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TASSEL MODIFICATIONS IN *ZEA MAYS*[1]

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Zea Mays L., in addition to its great economic importance, is preeminent among plants as a tool in the study of heredity. However, even though our knowledge of maize genetics has made rapid and often spectacular advances, certain problems involving basic morphology of the plant have been left unanswered. Foremost among these is that of the pistillate inflorescence, or ear, the structure of which has been discussed elsewhere (Nickerson, 1954). Another equally basic problem involves the staminate inflorescence, or tassel. Anderson (1951) briefly summarized botanical knowledge dealing with this inflorescence, and Alava (1952) showed how certain maize races could be characterized on the basis of information obtained from their tassels.

Preliminary studies on tassel morphology by the senior author indicate that the somewhat stereotyped and simple construction of tassels is misleading; certain parts apparently have been subjected to reductions even greater than those affecting corresponding ear parts. Morphological analysis of the tassel as it occurs atop a typical maize plant is even more difficult than morphological analysis of the ear.

One source of information on ear morphology was through studies of certain genetic forms in which particular parts were present in an accentuated form. It was felt that the same technique might profitably be applied to the tassel, since variation in maize tassels is, as in other parts of this specialized grass, variation on a theme. Specimen tassels from the collecton of sixteen tassel mutants assembled by the junior author were therefore examined. They contained a wealth of material;

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a search of the literature revealed that, in addition to the fact that several of them had not been described, many of the known forms had very meager descriptions. Since knowledge of the tassel mutants in themselves will serve both as a preliminary step in analysis of tassel morphology and as a basis for their employment in studies involving gene interaction, fuller descriptions of these anomalous forms are given.

We have attempted to give below a careful description of how each mutant type affects structures present in tassels and ears of North American corn-belt maize. Plants of each mutant have been bred to various combinations of two widely known corn-belt inbreds, CC5 and L317, sufficiently often to allow meaningful comparisons to be made between them. It must be remembered, however, that the standard stock is largely responsible for these particular manifestations, and that the background here employed was one found to be well adapted to growing conditions in southern California. Certain forms which might logically be included in this discussion, such as Corn-grass, Teopod, Silky-1 and Silky-2, were not studied. Silkless, a well-known ear anomaly, also was not included, because in our stocks Silkless tassels are indistinguishable from those of Standard plants.

It is possible to construct a key by which these tassel mutants may be separated. However, since even in relatively homogeneous stocks, an example of one mutant may sometimes match the description of another, such an artificial device cannot be too heavily relied upon. A key is here intended only to show certain general trends among the sixteen forms; it may or may not indicate underlying genetic and physiological similarities. The several descriptions given later are arranged in the numerical order indicated in the key.

KEY TO CERTAIN TASSEL MUTANTS

A. Tassel of normal (Standard) or nearly normal proportions
  B. Tassel with silks
    C. Pollen shed; fruits formed
      D. Fruits on proximal branch areas from imperfect florets ..... *Ts₂* — 6
      D. All fruits from perfect florets ..... *ts₇* — 8
    C. No pollen shed; no fruits formed ..... *ts₃* — 9
  B. Tassel without silks
    C. Glumes undeveloped ..... *Vg* — 13
    C. Glumes well developed
      D. Glumes long (average 11.5 mm.) ..... *Tu* — 14
      D. Glumes near normal length (average 8–10 mm.)
        E. No pollen shed ..... *ms₁* — 10
        E. Pollen shed
          F. Up to ¼ or ⅓ of branch tips sterile; pedicellate spikelets often with several sets of florets ..... *bd* — 11
          F. Branch tips never sterile; pedicellate spikelets not branched ..... Club — 12
A. Tassel of abnormal proportions
  B. Tassel with silks
    C. Half or more of tassels pistillate; staminate spikelets confined to middle areas or outer halves of branches; spikelets with no more than two florets each
      D. Branches indeterminate, mostly ending in immature pistillate structures ..... *Ts₃* — 3
      D. Branches otherwise
        E. Spikelets loosely spaced on branches ..... *ts₃* — 2
        E. Spikelets crowded on branches ..... *ts₁* — 1
    C. Tassels either staminate, pistillate, or mixed; if mixed, staminate spikelets often with more than two florets

D. Extra florets developed on both sessile and pedicellate spikelets; average peduncle length 10 cm. or less.....*Ts*$_8$ — 7
D. Extra florets developed on pedicellate spikelets only; average peduncle length more than 10 cm.
E. Seed set very sparsely if at all; average glume length 6 mm.....*ts*$_1$ — 4
E. Seed set in noticeable quantities; average glume length 8.5 mm.....*ts*$_4^a$ — 5
B. Tassel without silks
C. Branches horizontal or slightly lax with reference to central culm.....*ra*$_1$ — 15
C. Branches upright, close to central culm.....*ra*$_2$ — 16

Certain measurements have been made on at least fifteen and often twenty-five plants of each mutant form, and averages of these data are given in Table I. *Peduncle length* is the distance from the uppermost leaf-bearing node to the node at which the lowermost tassel branch arises. *Tassel length* refers to distance from the node at which the lowermost tassel branch arises to the tip of the central culm. *Branching area* is that distance along the central culm from the lowermost branch node below the central spike; it is included within the tassel length. *Primary branches* are axes of the second order, when the main culm of the plant is considered to be an axis of the first order. The percentage values for peduncles and branching areas were obtained by dividing these respective lengths by the sum of peduncle and tassel lengths.

These same data are presented graphically in fig. 1 by means of a pictorialized scatter diagram (Anderson, 1949). The diagram is meant only to indicate the average extent to which each of the mutants departs from average measurements of Standards. Limits were chosen so that Standard averages would always be char-

TABLE I

AVERAGE MEASUREMENTS OF CERTAIN MORPHOLOGICAL FEATURES IN TASSELS OF NORMAL AND MUTANT MAIZE FORMS

Form	Peduncle length in cm.	Tassel length in cm.	Branching area in cm.	Number of primary branches	% peduncle of whole tassel	% branching area of whole tassel
Standard	17.1	35.0	10.4	14	33	20
(1) Tassel-seed 1 (*ts*$_1$)	6.3	23.4	8.5	16	21	29
(2) Tassel-seed 2 (*ts*$_2$)	4.9	26.4	9.7	21	16	31
(3) Tassel-seed 3 (*Ts*$_3$)	3.9	22.5	9.0	26	15	34
(4) Tassel-seed 4 (*ts*$_4$)	16.2	25.2	19.1	34	39	46
(5) Tassel-seed 4^a (*Ts*$_4^a$)	14.4	24.8	16.3	43	37	42
(6) Tassel-seed 5 (*Ts*$_5$)	13.0	33.5	12.4	24	28	27
(7) Tassel-seed 6 (*Ts*$_6$)	10.0	18.5	12.0	36	35	42
(8) Tassel-seed 7 (*ts*$_7$)	17.9	33.1	15.0	23	35	29
(9) Tassel-seed 8 (*ts*$_8$)	18.0	31.9	8.8	14	36	18
(10) Male-sterile 1 (*ms*$_1$)	19.0	33.3	10.8	18	36	21
(11) Branched-silkless (*bd*)	15.1	34.4	10.7	18	31	22
(12) Club (*club*)	13.9	30.3	10.8	20	31	24
(13) Vestigial glume (*Vg*)	14.9	35.3	11.7	20	30	23
(14) Tunicate (*Tu*)	13.7	33.3	12.1	22	29	26
(15) Ramosa 1 (*ra*$_1$)	14.6	33.8	28.0	72	30	58
(16) Ramosa 2 (*ra*$_2$)	12.0	27.7	21.7	67	30	55

acterized by long flags. Thus, similarity to Standard in both graph position and flag lengths means that a particular mutant departs relatively slightly from a normal form. The converse is also true; the farther away in position and the greater the flag deviations from Standard, the more a given mutant differs in form.

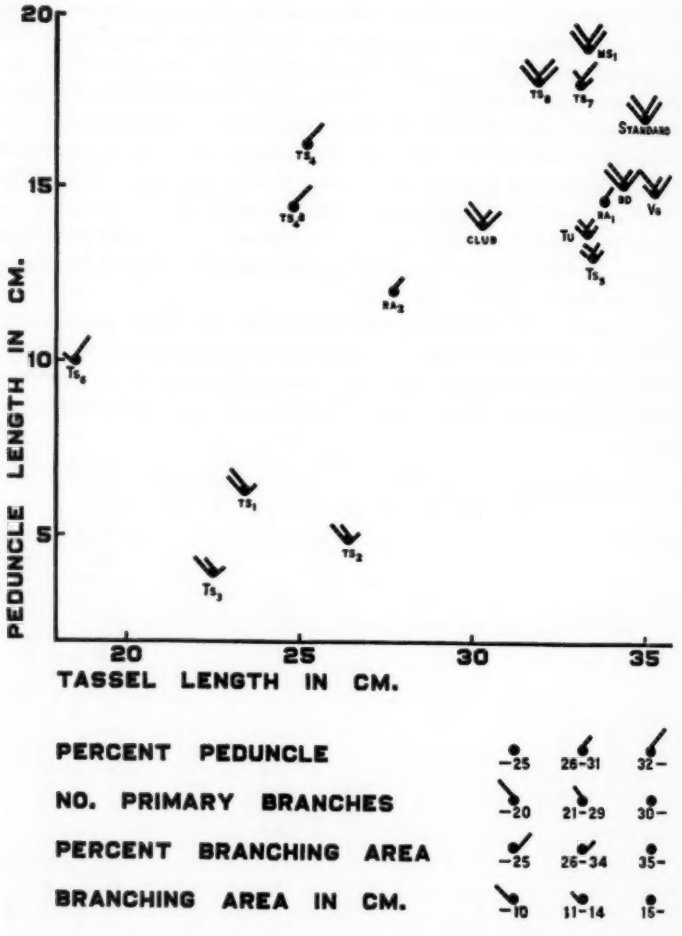

Fig. 1. Pictorialized scatter diagram of information contained in Table I, showing relationships between certain measurable features in tassels of normal and mutant forms of maize. Further explanation in the text.

DESCRIPTIONS

Standards, L317 and CC5 (pl. 22, fig. 1).—

Various mixtures of these two corn-belt inbreds were used. The history of Lancaster Surecropper, from which M. T. Jenkins developed L317, has been reviewed by Anderson (1944b). Wisconsin Inbred CC5 has an ancestry in the open-pollinated maize which was common to that section. Anderson and Brown (1952a, 1952b) showed that these corn-belt forms were various mixtures of Northern Flint and Southern Dent races. Nickerson further pointed out (1953) that these two races had previously been mixed in some degree, and that the excellent hybrid vigor manifest in present-day crosses, such as those between these two standards, is based on rather small differences. Ears are 14- to 18-rowed, 8 to 10 inches long, and bear bright yellow, dented kernels.

1. *Tassel-seed 1 (ts_1)* (pl. 23, fig. 1).—

First described as "tassel-ear" by Emerson (1920), this mutant was classified as Tassel-seed 1 by Emerson *et al* (1935), and assigned by them to Chromosome 2. Emerson originally described the inflorescence as being completely pistillate, compact and distinctly ear-like, with "glumes and palae short, broad and rounded, in all respects much like those of true ears." He noted that these characters could be observed in both mature and immature tassels as well as in poorly pollinated mature ones. It may be added that each pair of pistillate spikelets is associated with a well-developed cupule (Nickerson, 1954). The branches are thickened so that they appear as wide green bands in adaxial view. In our cultures, as in Emerson's, seed set was good and very often both florets of a spikelet develop a caryopsis. This development obscures any evidence of regular rowing in the central spike.

Emerson noted the general plant weakness in comparison to sibs, profuse silk production in the tassel, a general lack of elongation in upper internodes, and early assumption of a pendant position by the tassel. In our stock, this pendant position is due to bending of the culm; in Tassel-seed 2, likewise a pendant form, it is attributable mostly to bending of the tassel proper. These differences are manifestations of the degree of condensation (Anderson, 1944a), at least in part. Spikelet pairs of Tassel-seed 1 are generally closely spaced, resulting in rigid branches, while those of Tassel-seed 2 are more widely spaced, resulting in lax branches. Emerson mentioned these relative spikelet-pair densities, but he did not call attention to their differing effects on the area of bending. However, his figures 10 and 11 show each form quite well.

In our stocks, branch tips most commonly end in sterile zones characterized by closely overlapping glumes. Occasionally at the very tip, these glumes simulate those of male spikelets; they sometimes even contain stamens, but no pollen shedding has been observed.

The ear of Tassel-seed 1 is slow to develop, and, as in Emerson's strains, fails to set fruit unless the tassel is either removed or poorly pollinated. It is normal except that, just as in the tassel, both florets of each spikelet often develop, obscuring evidence of regular rowing.

2. *Tassel-seed 2 (ts_2)* (pl. 23, fig. 2).—

Emerson (1920) originally described this mutant, located on Chromosome 1 (Emerson *et al*, 1935), as "tassel-seed," and noted that the tassels were loose, like those of normal plants, with individual spikelets more or less separated. Our material never showed individual spikelets, but always paired spikelets. In Emerson's specimens, spikelet pairs sometimes occurred more densely, "but not ear-like in any way." Although it rarely occurred, he noted that staminate flowers might develop with pistillate ones throughout the entire tassel, but he did not determine whether these male florets were functional. He also observed that glumes and "palae" (paleas and lemmas) of such male spikelets were long, narrow, and pointed, as in normal tassels, while in female spikelets these parts were shorter, broader, and more rounded.

In our material, spikelets were either female or perfect, no male spikelets having been observed. On perfect spikelets, glumes were elongate and near normal. Also, each spikelet pair was associated with a cupule which was often elongated above spikelet pairs located on central spike tips. Kernels developed on nearly all spikelets; in many, as with Tassel-seed 1, both florets were functional and two kernels were formed.

Each tassel branch is thin, with spikelet pairs more widely spaced in its distal portion, but the base may be as thickly set as any found in Tassel-seed 1. Tassels of this mutant are pendant, but differ from those of Tassel-seed 1 plants in that the bending is mostly accomplished in the tassel rather than in the supporting culm. This point is discussed further with regard to Tassel-seed 1 above.

Ears of Tassel-seed 2 develop to a degree depending on the fate of the tassel. If little or no successful pollination takes place, ears are developed rapidly, but always later than on normal sibs. If tassels are removed soon after their appearance, ears are formed about the same time as in normals. These results are in accord with the findings of Emerson. Like most other tassel-seeded forms, second florets in many spikelets set fruit, after the manner characteristic of Country Gentleman sweet corn (Weatherwax, 1916), so that regular rowing may be obscured. When ears develop, they are of normal size.

3. *Tassel-seed 3 (Ts_3)* (pl. 24, fig. 1).—

The first published mention of this dominant mutant was made by Phipps (1928), who stated that "a third type of tassel seed designated as Tassel-seed 3 has been studied by Emerson, but the data have not as yet been published." Emerson *et al* (1935) also listed Tassel-seed 3 as being an unpublished discovery of Emerson's. They noted that this form was similar to Tassel-seeds 1 and 2, except that the inflorescence was generally mixed pistillate and staminate, and that usually pollen could be obtained. The gene is located on Chromosome 1.

Tassel-seed 3 tassels are easily recognizable, but, like other forms, they are variable in appearance. Branches bearing distichously arranged pistillate spikelets resemble flat green ribbons on their adaxial surfaces; both branches and central spikes most often end in tapering sterile rudimentary pistillate spikelets. Often, these sterile spikelets have an appearance of being whorled rather than distichously arranged. About three-fourths of our specimens produced some spikelets from which the florets shed pollen. These staminate spikelets are imperfect, most commonly produced on proximal portions of branches and central spikes and sometimes separated by sterile zones from pistillate regions. An occasional branch is entirely staminate and ends with a zig-zag axis, but most branches which bear staminate spikelets end in the characteristic pistillate tips described above. Tassels also are lacking in stiffness, thus becoming pendant as soon as they are exserted. The upper three to five internodes of Tassel-seed 3 plants do not elongate to the degree common in Standards, and as a result a rather tight collar of leaf sheaths is formed covering the lower sixth of each tassel. One tassel in our culture was infected with smut *(Ustilago zeae)*, a probable reflection of the extreme growth and lasting succulence of tassel parts. Emerson (1920) observed, and Dr. E. G. Anderson agreed, that Tassel-seeds 1 and 2 were highly susceptible to smut, but this year we noted no infections in any of our stocks except Tassel-seed 3.

There were often instances in which a spikelet pair consisted of one staminate and one pistillate spikelet; in these mixed pairs, the staminate one is always pedicellate. No perfect florets were observed, and only one floret in any particular pistillate spikelet would form a caryopsis. Cupules are well-developed adaxial to both pistillate and mixed spikelet pairs.

The ear of Tassel-seed 3 shows very few secondary florets, although Emerson *et al* (1935) mentioned that such florets do develop. In other respects, the ear resembles that of a Standard plant.

4. *Tassel-seed 4 (ts_4)* (pl. 24, fig. 2).—

First reported by Phipps (1928), and also as Sorghum Tassel (Hayes and Brewbaker (1928), ts_4 was assigned by Emerson *et al* (1935) to Chromosome 3. Phipps described the tassel as being tassel-like in structure but predominantly pistillate-flowered, and stated that when it emerged it was a mass of silks. Our material showed tassels much shorter than normal, with an abnormal number of weak branches held upright by a tangled growth of silks. In Phipps' stock, mature tassels were studded with kernels, usually densely packed together, especially on the central axis of the tassel, and not arranged in regular rows. Our specimens varied from setting fruit to this extent to setting no fruit at all. Phipps interpreted this irregular rowing as a result of development of a second floret in each spikelet; with this finding we are in agreement. In both his material and in ours, tassel branches were short and had distichously arranged spikelets, the spikelets on the proximal branch and the lower central spike producing stamens which contained functional pollen. Tassel glumes were short and papery, but we cannot agree with

Phipps that they were similar to glumes of a normal ear; we observed no glume induration. We noted also that sessile spikelets rarely branched, while pedicellate ones often formed short branches bearing two to six spikelets. Our standard stock has an average condensation index of 1.3; spikelets may occur at a given node in pairs, in 4's, in 3's and 5's and occasionally in 6's. As in Phipps' stock, both florets of each spikelet always developed, and thus each node had at least four and occasionally as many as twelve florets in addition to possible extra ones formed on branches of proliferated pedicellate spikelets. Phipps mentioned that careful study of his material showed "a few multi-flowered spikelets."

Silks were produced only from pistils, and such florets were always imperfect. No glumes were modified into silks, as Phipps reported. It is doubtful if his observation is accurate, because he noted "the basal parts of such glumes were normal." The silk-like structures were most likely awns, and if so, they were probably produced not on glumes but upon lemmas. We observed no such structures in this mutant, but in a mutant combination not reported on here, awns are developed on the lemmas. In some tassels, spikelets were sterile, producing neither silks nor stamens. These sterile spikelets were most common on branches between the proximally located obviously staminate areas and the distally located obviously pistillate areas. Characteristic of our Tassel-seed 4 stock were both its generally light set of fruit in the tassel and production of staminate and pistillate florets in widely varying amounts. No cupules were developed adaxial to any spikelet pairs of the tassel.

Ears of Tassel-seed 4 were often shorter than normal because of failure of the tip to mature; they developed better if tassels were removed early. In our stocks, no excessive development of silks was noted, but Phipps reported that some glumes were modified into silks. Development of second florets, referred to by Phipps as common, was apparently much less common in our stock, and regular rowing was not obscured. Glumes were usually less indurated than in normal ears.

5. *Tassel-seed* 4^a ($ts_4{}^a$).—

This allele of Tassel-seed 4 was found by E. G. Anderson in a background stock of CC5 × L317 which had been exposed to radiation at Eniwetok. Crosses made by the junior author between this mutant and Tassel-seed 4 showed the two types to be allelic.

The tassel of Tassel-seed 4^a resembles that of Tassel-seed 4, but the quantity of seed set is much greater. Pollen is much more freely produced than in Tassel-seed 4. Pistillate florets which set fruit are always borne on pedicellate spikelets and are generally imperfect, but some perfect florets have been found which always appeared to set fruit. In general, pistillate florets are confined to the outer third of branches. The central spike is sometimes all staminate, with several extra florets produced on short branches which are proliferations of pedicellate spikelets. Cupules are sometimes weakly developed on the culm of the central spike, but their presence is not universal. Average lengths of glume are about half again as great as those of Tassel-seed 4.

In Tassel-seed 4^a a few pedicellate spikelets have a tendency to proliferate slightly in the upper (distal) third of the ear. After kernels are removed, the right-angled insertion and excessive lengths of the glumes, paleas and lemmas of this allele give the cob a markedly different appearance from that of Tassel-seed 4.

6. *Tassel-seed 5 (Ts_5)* (pl. 25, fig. 1).—

Although this mutant is attributed to Emerson (1932), the only mention of Tassel-seed 5 in his paper was its inclusion on Chromosome 4 of a linkage map (see his fig. 1, p. 145). Emerson *et al* (1935), in a brief description, noted that it contained both silks and anthers but was not compacted as in Tassel-seed 4. In our material, tassels were very close to normal proportions, but they were never exserted as far as in normal sibs. Apparently this condition was due to lack of elongation of the internode directly below each tassel, as the plants appeared to be normal in height (Table I and fig. 1). Silks are much shorter and more scattered than in previously discovered tassel-seed forms. Their occurrence varies from very few being located in small branch areas (either basal or terminal), to being uniform over the entire tassel.

Spikelets may bear either staminate, pistillate, or perfect florets, but these types occur in specific places. Imperfect pistillate spikelets are usually located in proximal parts of lower branches, and when they occur on central spikes, it is only in their lower regions. Cupules are well developed adaxial to such spikelets, which most often occur as sessile members of spikelet pairs; the pedicellate ones are always both imperfect and staminate. The imperfect pistillate florets form most of the caryopses. Perfect spikelets are never associated with well-developed cupules, and seldom set fruit unless there are few or no imperfect pistillate spikelets present. Even here, however, fruits are formed predominantly on sessile spikelets. If a fruit is set in such a floret, the stamens are generally not exserted, but examination shows their anthers to be full of pollen and occasionally dehisced inside the palea and lemma. Imperfect staminate spikelets occur wherever the other two forms are absent; they never have any trace of silks, and their stamens shed pollen copiously. Silks not pollinated quickly withered.

The ear of Tassel-seed 5 in our strain developed very few second florets, but Emerson *et al* noted that "secondary florets develop in ears." Otherwise, the ear closely resembles that of our Standard stock.

7. *Tassel-seed 6 (Ts_6)* (pl. 25, fig. 2).—

The first apparent reference to this dominant mutant was made by Emerson (page 14 of the Maize Genetics Cooperation Newsletter for January, 1933). In subsequent 'Newsletters', he established that this mutant is located on Chromosome 1, but no description of its morphology has been published.

Plants of Tassel-seed 6 average about one foot shorter than normal sibs. Tassels appear at the same time, but they are only half as long and are borne on peduncles whose average length is only three-fifths as great as those of Standards. In general

appearance, the tassels resemble those of Tassel-seed 4, but they usually set a considerably greater number of fruits. Branches are numerous, short, thin, and lax, with no cupules developed adaxial to any spikelet pairs. They end in many small florets which rarely form fruits and which may be borne on whorled instead of distichous spikelets. Spikelet pairs are closely set on both branches and central spike. Scarcely any distinction exists between pedicellate and sessile individuals, as each one forms several closely packed florets. Short branches with 4 to 12 spikelets are developed on the central culm, giving it a thickened appearance. Glumes are hyaline, without chlorophyll, and extremely short, averaging about 5 mm. in length.

Tassels of this mutant have two general forms. Approximately half of them are entirely pistillate; the others produce staminate spikelets on proximal branch areas and on the lower third of their central spikes. Tassels of this latter sort may have their remaining spikelets constructed in one of three different orders which occurred in our samples with equal frequency: (1) florets bearing silks might also bear stamens and thus be perfect; (2) they may bear no stamens and be imperfect, or (3) a zone of perfect florets of variable length may grade off into a tip which is entirely imperfect. Stamens in perfect florets often neither extruded their anthers nor shed pollen, but those in staminate florets invariably shed good quantities of pollen. Silks are produced only from pistils, but an occasional lemma near a branch tip may develop a short awn.

Ears of Tassel-seed 6 are not well developed unless the tassel is removed early. There is the same characteristic production of second florets found in other tassel-seeded forms, so that regular rowing is often obscured. In other respects, ears are comparable with those of Standard plants.

8. *Tassel-seed 7 (ts_7)* (pl. 26, fig. 1).—

This mutant was found by E. G. Anderson at Pasadena in material which had been exposed to radiation at Bikini. (See Anderson *et al*, 1949, for a further discussion of radiation effects.) It is not known to which chromosome it should be assigned. Tassels have proportions and dimensions of normal ones, and, like Tassel-seed 5, have few functional pistillate florets. Silks are generally short and evenly distributed; their occurrence varies from almost none to profuse. Each silk arises from a pistil in a perfect floret; florets which do not produce silks are imperfect and staminate, producing pollen freely. Only two florets are borne on each spikelet. No cupules are developed in the tassel. The number of fruits seldom exceeds twelve per tassel, and on about half the tassels they are not formed at all.

The ear of Tassel-seed 7 commonly bears up to six short branches at its base. These branches are produced from pistillate spikelets, and an adaxial cupule is present above each one. The sessile spikelet of such a pair is generally not fully developed. These basal branches do not form any viable kernels. Silks form only slightly if at all, even though the branches remain meristematic after cessation of growth elsewhere throughout the plant. Occasionally, two or three small

branches are found on the shank below an ear. These sub-ear structures have always been sterile, and none of them developed beyond the point at which pistillate spikelets could be easily recognized.

9. *Tassel-seed 8 (ts_8)* (pl. 26, fig. 2).—

This mutant, found by E. G. Anderson at Pasadena, was segregating in a culture of chromosome translocations. It is known to be linked to white endosperm (y_1). Both ts_8 and ms_1 tassels are male-sterile, in chromosome 6 and linked to y_1, but the two forms are not allelic. Further, since Ts_8 sets no fruit but produces silks and since Emerson *et al* (1935) mentioned no male-sterile forms which so behaved, the material is here described as an eighth tassel-seed form. In over-all appearance, plants resemble normal sibs. Tassels are of standard proportions and size, but glumes are occasionally shorter than normal and the spikelets never swell as time for anthesis approaches. Silk production varies from none to a profusion as great as may occur in Tassel-seed 7. Four-fifths of our population of this mutant had tassels in which no stamens were formed; in the remaining one-fifth, they were formed but their anthers were empty. No stamens are ever exserted. Silks arise from abortive pistils. Three florets per spikelet may send out silks, but no fruits are ever set regardless of ample exposure to pollen. Branch tips are often undeveloped.

The ear of Tassel-seed 8 produces a great profusion of silks; 4 to 6 are formed by each spikelet. The first silk formed (from the lowest flower) is of greatest diameter, and its pistil forms a caryopsis. Each of the others sends out a silk which generally is exserted, but no fruits are formed. Kernels are arranged in rows, and, except for the fact that many extra silks protrude between the tightly packed kernels, a mature ear resembles that of a Standard plant.

10. *Male-sterile (ms_1)* (pl. 27, fig. 1).—

This mutant was reported by Singleton and Jones (1930) and listed by Emerson *et al* (1935) as occurring on Chromosome 6. Singleton and Jones noted that tassels of male-sterile plants were more slender than normals, that anthers failed to extrude, and that no pollen was shed. They also reported that Beadle found meiosis essentially normal but that the haploid nucleus did not go through the first mitotic division, and by the time pollen should be shed it was difficult to find even the remnants of spores. Emerson *et al* noted further that shriveled anthers were exserted much later than in normal sibs.

In our material, no stamens were exserted. In other respects, tassels of ms_1 resembled those of our Standards. There was a tendency for the tassel to emerge sooner than with normals, and this tendency was reflected in slightly longer pedicels (Table I and fig. 1) since elongation ceased at the same time as in normal sibs.

The ear is normal. Singleton and Jones reported that ms_1 is closely linked to the white endosperm locus (y_1) with about 5 per cent recombination. Our material behaved in the same fashion; white kernels almost invariably produced male-sterile plants.

11. *Branched-silkless (bd)* (pl. 28, fig. 2.)—

First described by Kempton (1934), this mutant is listed by Emerson *et al* (1935) as occurring on Chromosome 7. Kempton noted that the division of the tassels into a central spike and branches is as definite as in normals, but that the tassels have a thickened appearance suggesting those of Tunicate plants. He attributed this thickening to development of short branches in place of paired spikelets, a condition which also occurred in our material. He also mentioned the fact that this branching was most common on central spikes, and that on the branches there was more tendency toward retaining a pedicellate-sessile form.

Kempton made no mention of sterility, nor did his illustrations show any, but in our material sterile areas occurred at branch tips and sometimes at the tip of the central spike. Not uncommonly lowermost branches were sterile throughout. In sterile areas, spikelets were less developed as distance from the central culm increased. Kempton noted that many plants shed pollen in good quantity, but stamens often were not fully exserted.

Ears of Branched-silkless are of two forms, a fact which Kempton likewise noted; his figures show each type clearly. In one type, each spikelet primordium develops into a short branch bearing female spikelet rudiments which never develop beyond the earliest stages. In the other type, such branch development is confined to the basal quarter of the ear, the upper three-fourths being composed of sterile spikelets with elongated and sometimes thickened glumes. That these branches develop from spikelet primordia on an otherwise normal cob can be easily shown by removal of the branches; underlying each pair adaxially is a well-developed cupule. It is this latter type which may occasionally produce a scattering of silks too short to become exserted. Kempton stated that his material was wholly without silks, but Emerson *et al* mentioned that the ear occurs "often without silks."

12. *Club (club)* (pl. 27, fig. 2).—

This mutant was first noted by E. G. Anderson and segregated from non-irradiated genetic stocks at the Caltech farm in Arcadia. Its chromosome length is unknown.

The tassel is shorter than normal, with branches held at angles approximating 45°. Branch ends do not droop and their thickly set spikelet pairs are fertile throughout. The central spike is exceedingly thick, and it is on account of this character that the mutant was named. This thickening is brought about by a shortening of internodes, so that the spikelets stand nearly at right angles to the central culm. Further, these closely spaced spikelets occur singly or in pairs; there is no pedicellate branch development such as is found responsible for creation of thickened portions of the central spike of Branched-silkless.

The ear of Club generally matures a week later than the tassel. Its silks are profuse, and there are 4–6 silks per spikelet, each from a rudimentary pistil—a condition also found in ears of Tassel-seed 8. However, Club ears are fasciated, the branching strongly resembling a type listed by Kempton (1923) as Bearsfoot (see his fig. 1 for a clear illustration). It is apparently caused by one or more incomplete divisions of the growing point when the ear is partly formed, followed by simultaneous development of each new point into a more or less independent ear tip. The upper half of such an ear is generally hollow, and no spikelets are formed on the inside walls.

13. *Vestigial glume (Vg)* (pl. 28, fig. 1).—

First reported by Sprague (1939), Vestigial glume was found to be a dominant mutation on Chromosome 1. It is easily noted in the tassel, where the hyaline outer glumes range from awl-shaped vestiges to nearly one-third normal length. Sprague pointed out that "flowering glumes" (lemmas) and "palets" (paleas) were also reduced in size, with the result that the stamens were nearly completely exposed. In our material, as in his, anthers generally dried up before dehiscence, but occasionally a plant shed viable pollen. Many specimens in our stock had sterile areas (i.e., no stamens were formed) at tips of branches and central spikes, in some cases involving the outer sixth of all branches. Generally, over-all tassel size was smaller and tassel construction, as exemplified by thickness of central culm and branches, was lighter than in normal sibs.

The ear of Vg is easily recognized, as Sprague pointed out, after removal of kernels. There are no chaffy upper and lower glumes, paleas or lemmas present, only short pedestals, each with a low, hard ridge on both upper and lower sides. Above each spikelet pair, in an adaxial position, is a cupule with somewhat reduced rachis-flaps (Lenz, 1948).

14. *Tunicate (Tu)* (pl. 22, fig. 2).—

According to Collins (1917a), this mutant has been reported from several sources and its origin is not known. Recently, it has been cited in connection with theories of maize origin (Mangelsdorf, 1948; Mangelsdorf and Smith, 1949). Cutler (1944) suggested that its widespread occurrence among Indian tribes was because of mystical significance attached to it. Emerson *et al* (1935) listed the character as occurring on Chromosome 4.

Tassels of heterozygous Tunicate plants have normal measurements in all visible parts except the glumes. The glumes are one-fifth to one-fourth longer than those on Standard tassels and enclose paleas and lemmas similarly elongated. The stamen length being normal, the anthers, especially in the central spike, are not fully exserted and therefore are not pendant at anthesis. Pollen is shed abundantly.

Ears of heterozygous Tunicate plants are easily classified. Collins (1917a, b) stated that "the glumes of the female inflorescence, or ear, are developed so that each seed [fruit] is entirely enclosed." Emerson *et al* (1935) likewise attributed

these covers to glumes. In our stock, paleas and lemmas were also elongated, and in many basal spikelets, paleas and lemmas of both upper and lower florets were noted. No fruit occurred in these lower florets, however, and regular rowing was externally apparent. The rachis of a Tunicate cob is rather flexible. Cupule development adaxial to each spikelet pair was not excessive in comparison with Standards; but in the Tunicate ear of Guarani maize sent to the senior author by Dr. P. C. Mangelsdorf, the cupules are much more apparent than is normally the case.

Homozygous Tunicate plants, according to Emerson *et al* (1935), are usually female-sterile. No homozygous plants were available in our collection.

An allele of Tunicate, tu^h, was reported by Mangelsdorf (1948) as being present in *Maiz chapolote*. How this allele would behave with our Standards as background was not determined.

15. *Ramosa 1 (ra_1)* (pl. 29, fig. 1).—

This form was originally described by Gernert (1912) under the name of *Zea ramosa*, and was listed by Emerson *et al* (1935) as Ramosa-ear 1, located on Chromosome 7. Gernert's description of the tassel was brief. In his stocks, tassels were slightly smaller than normal, invariably much branched and cone-shaped. Collins (1917a, b) noted that branches were much more numerous than normal. Kempton (1921) reported 400 as an extreme number; the branches gradually decreased in size upward, the transition from branches to pairs of spikelets being imperceptible. A short central spike was characteristic in our specimens—a fact which Kempton had likewise noted in his plants but which Collins did not mention. It was not possible, according to Collins, to distinguish between plants heterozygous for Ramosa 1 and normals. However, in our material, it was quite simple to separate them; in five F_1 families of Ramosa 1 $\times$ Standard, four with 10 plants and one with 9 plants, separation was easily made into 24 normal and 25 heterozygous individuals. Resemblance of tassels of homozygous Ramosa 1 plants to grass panicles is striking (Kempton's plate 13 is typical). Tassels of plants heterozygous for this character were intermediate between a pyramidal paniculate tassel and a normal one, identical to one figured by Kempton in his plate 14.

The ear of Ramosa 1 was described by Gernert as being much branched, without male florets, covered with husks, and composed of a mass of kernels borne on numerous irregular branches. His description applies to our specimens as well, except for two other points: (1) branches on a Ramosa 1 ear are about as numerous and have much the same irregular whorled arrangement as do those of the tassel; (2) there are no adaxial cupules at the junctions of ear branches and central culm. Cupules were present, however, adaxial to each spikelet pair of the branches. No other ear among the mutants in this collection is so organized. It was also a common occurrence for tips of those branches originating near the upper part of the ear to be sterile.

16. *Ramosa 2 (ra_2)* (pl. 29, fig. 2).—

The only published reference to this mutant is found in Emerson *et al* (1935), which simply listed Ramosa 2 as being located on Chromosome 3 and credited its discovery to Brink.

Ramosa 2 has a tassel characterized by stiff upright branches which remain closely appressed to the central culm. The central spike region does not bear short-pedicelled spikelet pairs; instead the spikes are borne on branches which decrease in length from base to apex. There is a pronounced transition from well-developed tassel branches bearing many pairs of spikelets to smaller branches bearing fewer spikelets, some of which appear to occur singly. As one proceeds acropetally, these multi-spikeleted branches are replaced by stalks each bearing only one pair of spikelets which are themselves borne on pedicels longer than normal. In the adaxial area of each of these branches and stalks, a small cupule-like depression in the central culm can be observed which is generally of a different color from the surrounding surface. Although these depressions and short stalks are not confined to Ramosa 2, they are here most common and best developed. The spikelet pairs in proximal areas of well-developed lower branches are likewise stalked and also have abnormally long pedicels, but there is no adaxial depression.

Pollen is shed freely, but much of it remains within the confines of the tassel because close proximity of branches does not allow unrestricted air passage. Each spikelet has two male florets, and each of these has three functional stamens. Tassel-seed 4^a might possibly be confused with Ramosa 2, as its tassels sometimes show the same tendency to have numerous stiff, erect branches and stalked spikelet pairs in the central culm region, with an abundance of pollen produced. It can be separated from Ramosa 2 by the lack of stalked spikelet pairs on lower branches and the fact that each of its branches end in a few sterile undeveloped spikelets.

The ear of Ramosa 2 sometimes ends in a staminate structure looking like a normal central spike. Most commonly, it produces scattered branches on the upper (distal) half of the cob, which in turn bear female spikelets in pairs. These branches are nearly always found in younger ontogenetic stages than the rest of the plant and consequently set seed only rarely. A branch originates by growth of what would normally be the pedicellate spikelet of a pair of kernel-bearing spikelets. No instances were observed in which the sessile spikelet of such a pair formed anything but a normal caryopsis. The spikelet pairs themselves are borne on short stalks; the cupule is bent at nearly right angles, and is adherent half to the stalk and half to the cob. In addition, these stalks are spaced rather widely apart, so that a cob of Ramosa 2 from which the chaff has been removed resembles a similarly treated cob of Coroico maize (Cutler, 1946).

SUMMARY

Morphological studies have been made on tassels and ears of sixteen mutant forms of maize. Four of these forms are reported for the first time, and the others, for which descriptions were either inadequate or non-existent, are here

described. Each genetic form was introduced into a standard background derived from the inbreds *CC5* and *L317*. The mutants studied included nine tassel-seeded forms: ts_1, ts_2, Ts_3, ts_4, $ts_4{}^a$, Ts_5, Ts_6, ts_7 and ts_8. Others studied were Male-sterile *(ms_1)*, Branched-silkless *(bd)*, Club *(club)*, Vestigial glume *(Vg)*, Tunicate *(Tu)*, Ramosa-1 *(ra_1)* and Ramosa-2 *(ra_2)*.

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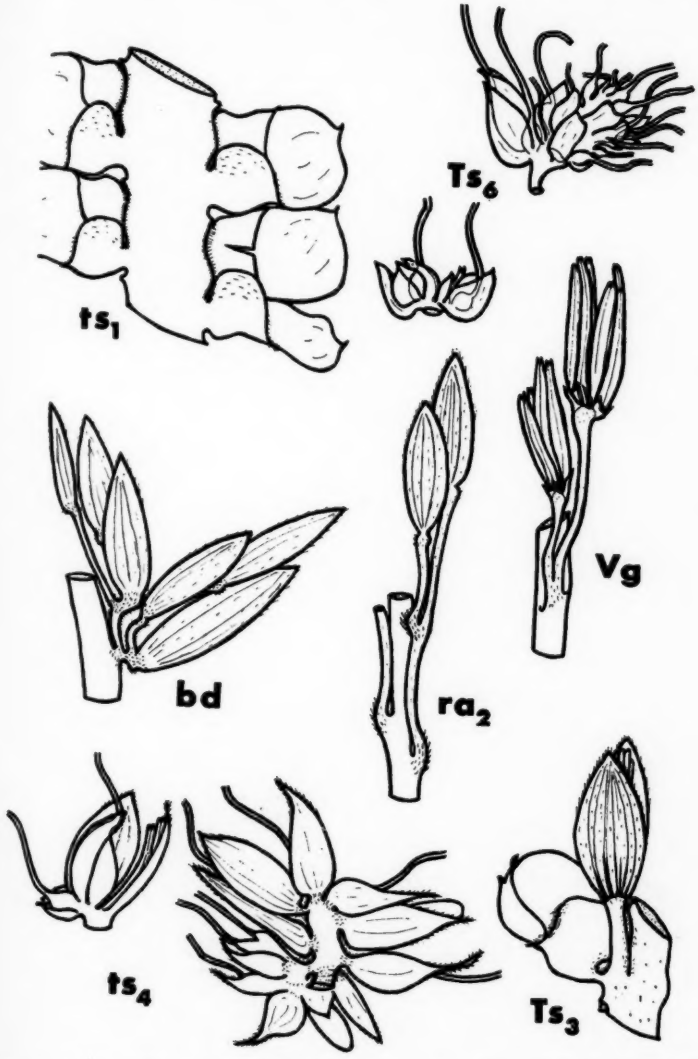

Fig. 2. Drawings to same scale of spikelet pairs found on lowermost primary tassel branches of certain mutants showing characteristic features: *ts*$_1$, adaxial view of thick, ribbon-like branch showing cupules and a developed second floret (silks removed). *Ts*$_6$, pedicellate (right) and sessile (below) spikelets with hyaline awnless glumes; pedicellate spikelet forms numerous naked small pistils. *bd*, both spikelet axes form extra spikelets. *ra*$_2$, an extra internode is found between the primary axis and point of departure of the sessile spikelet. *Vg*, glumes do not develop, so stamens are left naked. *ts*$_4$, sessile spikelet left has one male and two female florets; pedicellate spikelet (right) forms numerous spikelets, with many of the thin glumes ending in soft awn-like tips. *Ts*$_3$, sessile female and pedicellate male in one spikelet pair; pedicellate axis adheres to edge of cupule for part of its length (silks removed).

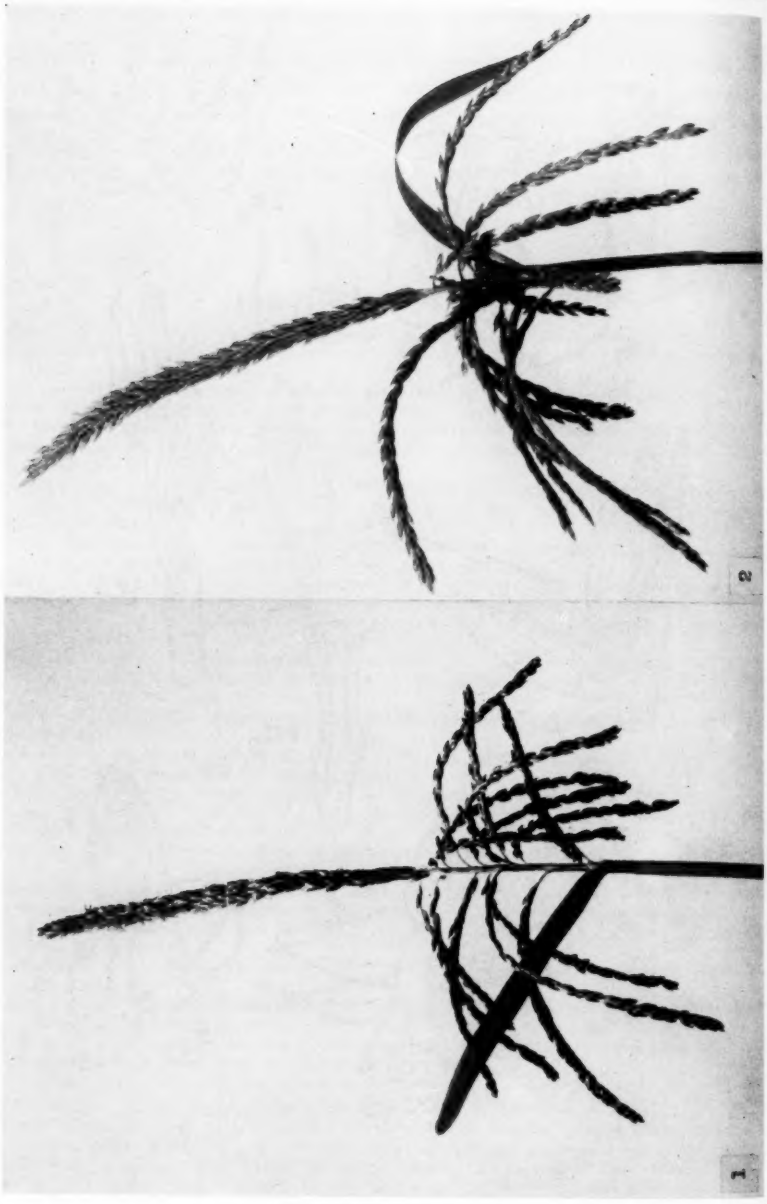

Fig. 1. Standard
Fig. 2. Tunicate (*Tu*)

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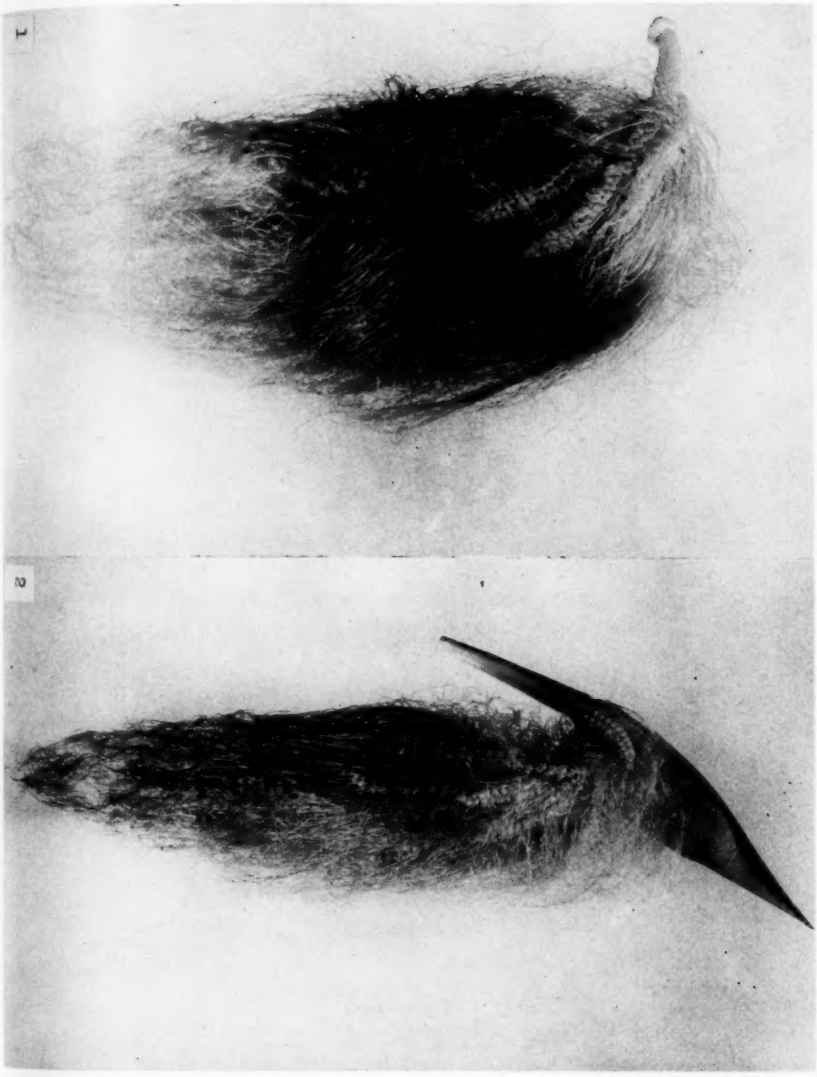

Fig. 1. Standard
Fig. 2. Tunicate (*Tu*)

NICKERSON AND DALE—TASSEL MODIFICATIONS IN ZEA MAYS

Fig. 1. Tassel seed 1 (*Ts*1). Fig. 2. Tassel seed 2 (*Ts*2).

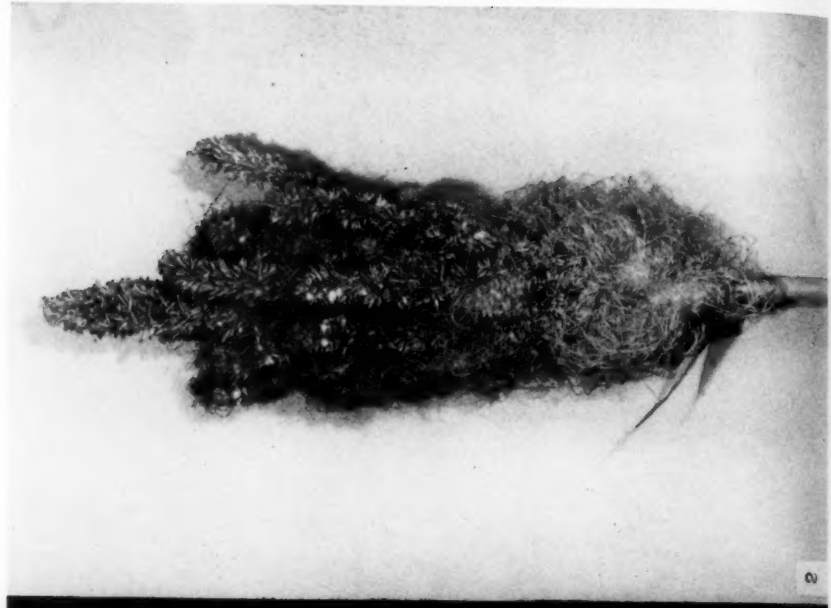

Fig. 2. Tassel-seed 4 ($1\frac{1}{2}\times$)

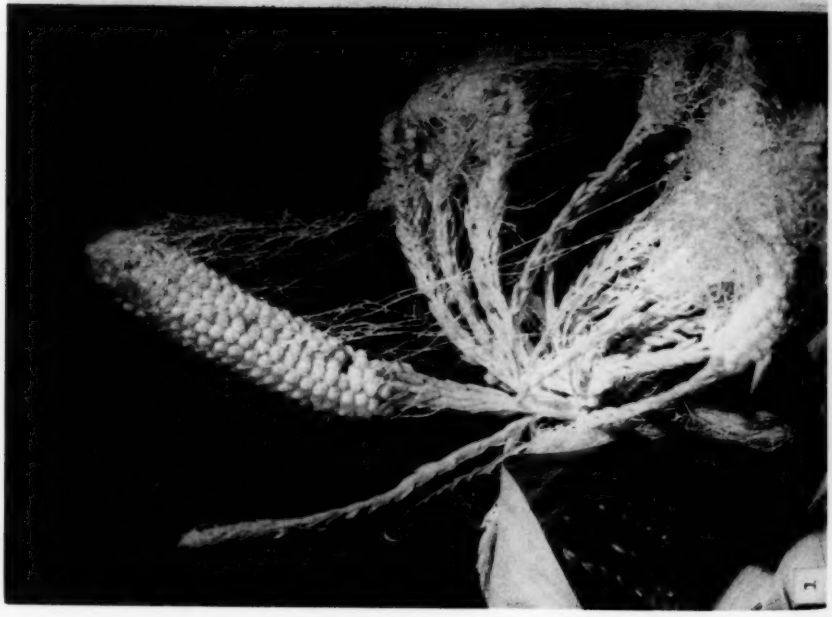

Fig. 1. Tassel-seed 3 ($1\frac{1}{2}\times$)

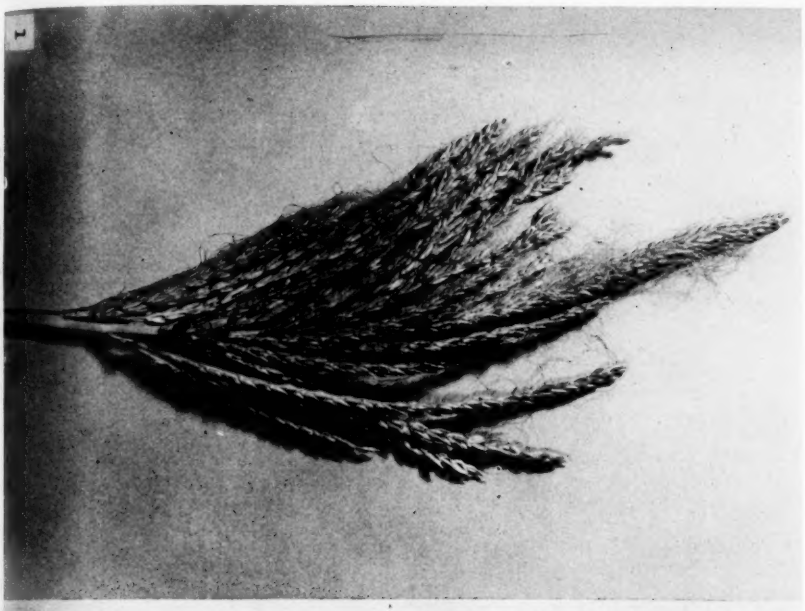

Fig. 1. Tassel-seed 5 (×2).

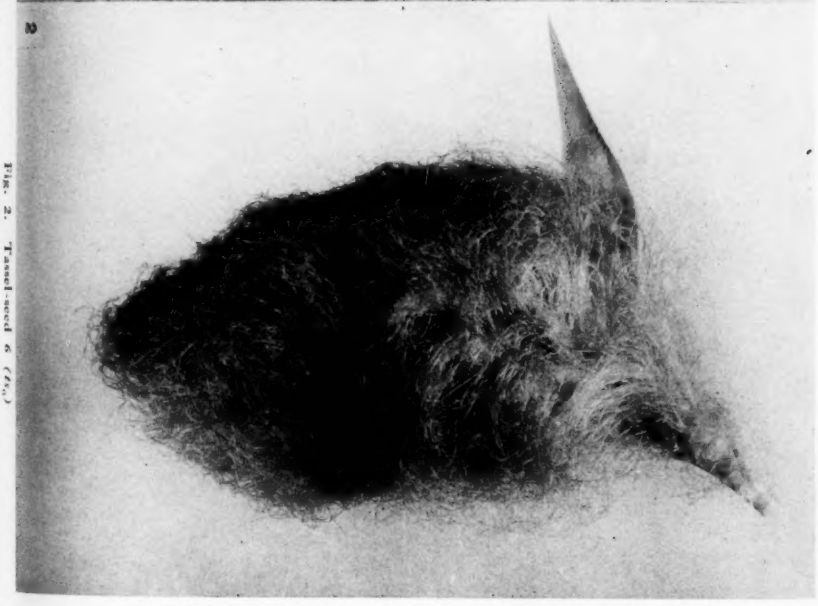

Fig. 2. Tassel-seed 6 (×2).

Fig. 1. Tassel-seed 7 (ts_7)

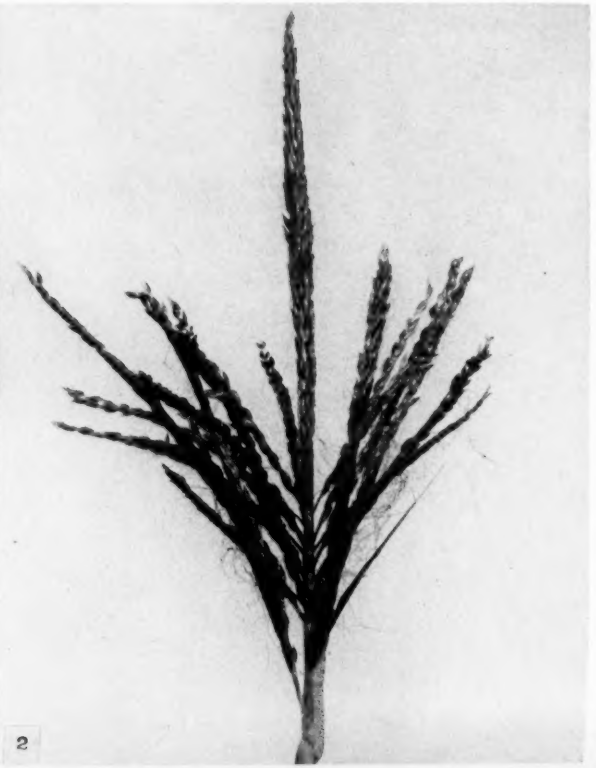

Fig. 2. Tassel-seed 8 (ts_8)

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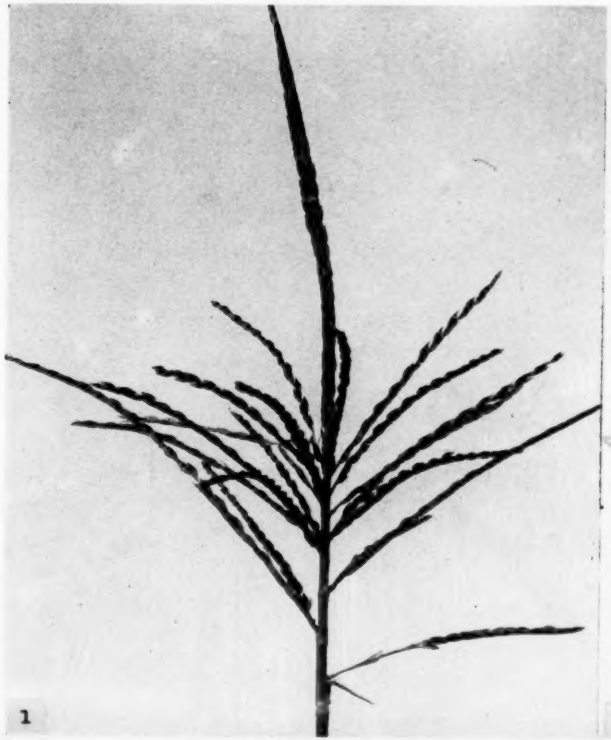

Fig. 1. Male-sterile 1 (ms_1)

Fig. 2. Club *(club)*

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Fig. 2. Tassel-seed 8 (ts_8)

Fig. 1. Tassel-seed 7 (ts_7)

NICKERSON AND DALE—TASSEL MODIFICATIONS IN *ZEA MAYS*

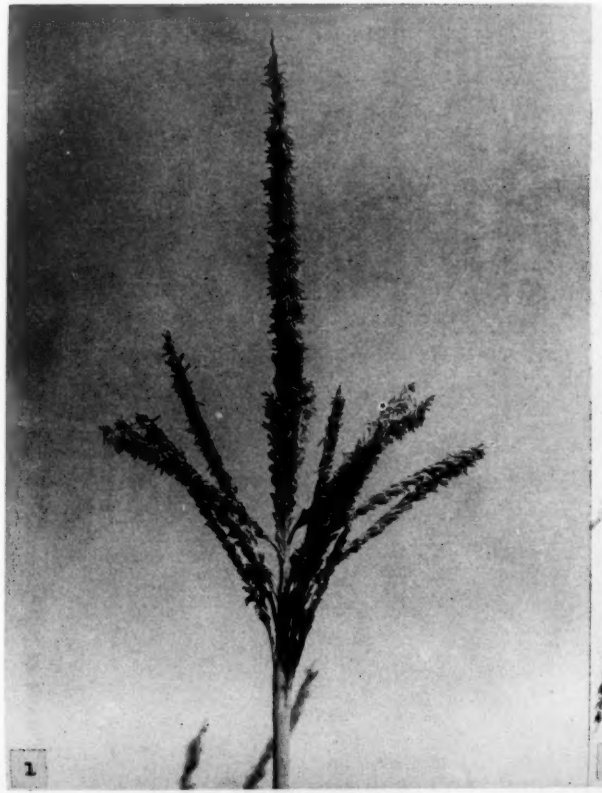

Fig. 1. Vestigial glume *(Vg)*

Fig. 2. Branched-silkless *(bd)*

Fig. 1. Vestigial glume (*Vg*)

Fig. 2. Branched-silkless (*bd*)

NICKERSON AND DALE—TASSEL MODIFICATIONS IN *ZEA MAYS*

A NEW SPECIES OF *DORYOPTERIS* FROM SURINAM*

KARL U. KRAMER AND ROLLA M. TRYON, JR.

In the course of examination of specimens in the fern collection of the Botanisch Museum en Herbarium, Utrecht, the senior author discovered a specimen of *Doryopteris* that seemed to be different from any species treated in the junior author's revision of the genus[1]. Further examination has proved this to be the case and it is here described as new.

DORYOPTERIS **conformis**, spec. nov.

Rhizoma modice crassum breviter repens, squamis elongatis angustissimis dense vestitum, partium hyalinarum cellulis latitudine maxime partem quintum longitudinis aequantibus; stipes obscurus laevis vel leviter rugosiusculus, fasciculis vascularibus duobus; lamina fertilis sterili similis coriacea, venatio libera; sterilis suborbicularis—quinquangularis, profunde bipinnatifida; fertilis conformis, profunde bi- vel tripinnatifida; receptaculum intramarginale plus minusve continuum; sporangia breviter pedicellata.

Typus: *Gonggrijp & Stahel (B. W.) 5699;* Surinam: Mt. Hendriktop, alt. 1080 m.; moist, sunny rocks; in Herb. Utrecht.

Rhizome moderately stout, short-creeping; scales of the apex of the rhizome very long and narrow, the cells of the hyaline portions at least five times as long as broad; stipe dark purple to black, naked or slightly scaly at the base, glabrous, smooth or minutely and irregularly roughened, with two vascular bundles at the base, terete; fertile and sterile blades similar, without proliferous buds, coriaceous; sterile leaf about 25 cm. long; blade 7 cm. long, suborbicular-pentagonal, deeply bipinnatifid with about 12 oblong, broadly rounded, entire or partially crenulate ultimate lobes; margin with a pale brown cartilaginous border; venation free; hydathodes prominent on the upper surface; fertile leaf about 25 cm. long; blade about 8 cm. long, suborbicular-pentagonal, deeply bi- to tripinnatifid, with numerous ultimate segments; primary segments broadly decurrent and surcurrent, the bases forming wings along the rachis with symmetrically concave sides; ultimate segments oblong-lanceolate, narrowly rounded, entire; soral lines continuous around the sinuses; sporangia short-stalked, i.e. the stalk somewhat shorter than capsule (which is 340–360 μ long), borne on a more or less continuous vascular commissure; spores subglobose, triplanate, slightly rugose, pale yellow-brown, about 55 μ.

Doryopteris conformis is most closely related to *D. lomariacea* from which it differs in the non-dimorphic fertile and sterile leaves, the segments of the fertile being much broader than in *D. lomariacea,* in the short-stalked sporangia and coriaceous texture of the blades; in *D. lomariacea,* the sporangia are long-stalked and the leaf-tissue is herbaceous.

This species is notable in that it is the only local endemic in the genus outside of southeastern Brazil. However, the Guiana Highlands represent a weak sec-

[1]Tryon, Rolla M. A revision of the genus *Doryopteris.* Contr. Gray Herb. 143:1–80. 1942.

*Issued November 17, 1955.

ondary center for the genus in South America. This is the sixth species known from there, not including the widespread and somewhat doubtfully allied *D. concolor;* a concentration of species exceeded only in the southeastern Brazilian Highlands. It is also significant that all the other five species, *D. lomariacea, sagittifolia, collina, varians,* and *pedata* var. *multipartita* are variously disjunct between southeastern Brazil and the Guiana Highlands. Whether *D. conformis* represents a local offshoot of *D. lomariacea* or whether it was evolved, as all other Guiana species evidently were, in southeastern Brazil and migrated via the Andes to the Guianas, can only be determined if it is eventually discovered in Brazil.

Explanation of Plate

PLATE 30

Fertile and sterile leaf of *Doryopteris conformis,* from type. × 2/3.

KRAMER AND TRYON—*DORYOPTERIS CONFORMIS*

A REVISION OF THE GENUS *CELASTRUS**

DING HOU**

Introduction

There are about 500 species which have been referred in the past to the genus *Celastrus;* of these half are African plants. In 1942 Loesener[1], in a review of the genus for Engler & Prantl's 'Pflanzenfamilien', transferred some of the African species to the genus *Gymnosporia* and some to the allied genus *Maytenus.* In indicating the geographical distribution of *Celastrus* only in Asia, America, Australia, and Madagascar, he seems to have been aware of the fact that the so-called species of *Celastrus* of Africa proper did not truly belong to that genus.

Loesener has expressed the opinion that the confusion regarding species limits in *Celastrus* and the synonymy indicate the need for a more precise study. I have attempted in this treatment to define the generic limits of *Celastrus* and its relationship with other closely related genera, to review and to check all the published binomials of *Celastrus,* and to clarify the complicated synonymy. I have also made a study of the morphological characters and geographical distributions of the different species. I have used the data to separate species or groups of species and to show their inter-relationships (fig. 1). All the *"Celastrus"* species from Africa proper have been excluded in this treatment, as they are referable either to *Gymnosporia* or *Maytenus.* I have tried to delimit definitely the three genera, *Celastrus, Gymnosporia,* and *Maytenus,* which have been very much confused. It is my intention in the near future to make a detailed study of these last two genera. This treatment of *Celastrus* includes two subgenera with thirty-one species and five subspecies.

The generic name comes originally from Theophrastos, who, however, designated with the Greek word κελαστρος (Kelastros) an evergreen tree *(Phillyrea),* that has nothing to do with our genus[2]. It is feminine in gender as used by Theophrastos, but Linnaeus in adopting it, made it masculine. It has already been pointed out by Airy Shaw[3] that under the International Rules the masculine gender must be retained. Hence, in this treatment, *Celastrus* is treated as masculine and I have standardized all the epithets accordingly.

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[1]Loesener, Th., in Engler, A. & Prantl, K. Die Natürlichen Pflanzenfamilien 2 Aufl. 20b:131, 134. 1942.

[2]Loes. loc. cit. 2 Aufl. 20B:132. 1942.

[3]Airy Shaw, H. K. in Curtis's Bot. Mag. 158:*t. 9394.* 1935.

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*An investigation carried out in the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment for the requirements for the degree of Doctor of Philosophy.

**Arnold Arboretum of Harvard University, Cambridge, Mass.

Issued November 17, 1955.

HISTORY

The genus *Celastrus* was founded and described by Linnaeus[4] in his 'Genera Plantarum' (1737). Later, in his 'Species Plantarum'[5] (1753), he described three American and two South African species. Only one of these, *Celastrus scandens*, is now retained in the genus *Celastrus*.

In 1824, Kunth[6] pointed out that some of the *Celastrus* species, for example, *Celastrus buxifolia* L., *C. montana* Roxb., *C. trigynus* Lam., etc., have peculiar characters and might well constitute a new genus. He gave a detailed description for that group of species, but provided no name for it. In 1834, Wight and Arnott[7] studied the Indian species of *Celastrus*, and, chiefly on the basis of ovule or seed characters, divided the genus into two sections, EUCELASTRUS and GYMNOSPORIA. They gave each section a very concise and clear description. In the section EUCELASTRUS, the ovary is free from the disc, the ovules have a cup-shaped aril at their base, and the seeds are surrounded by an entire fleshy aril. In the section GYMNOSPORIA, which corresponds to Kunth's unnamed genus, the ovary is half-immersed in the disc, the ovules are naked at the base, and the seeds are apparently without an aril or with a very short, imperfect, and membranaceous one at the hilum. In 1862, Bentham and Hooker[8] elevated the section GYMNOSPORIA to the rank of genus. At present the limits of the genus *Celastrus* are identical with those of section EUCELASTRUS of Wight & Arnott.

GENERIC RELATIONSHIPS

Gymnosporia and *Maytenus* are closely related to one another and to *Celastrus*. They often have been confused with *Celastrus* both in the literature and in the herbaria. Exell[9] has pointed out that Loesener's[10] separation of *Gymnosporia* from *Maytenus*, on the presence in the former of either thorns or inflorescences borne on short shoots, appears artificial. He says: "There seems little point in keeping the two genera distinct."

After examining all available specimens of *Celastrus*, *Gymnosporia*, and *Maytenus*, I have concluded that they are distinct though very closely related genera. The following table for distinguishing the three genera is based on a consideration of several characters taken together and not any one single character taken by itself (pl. 31).

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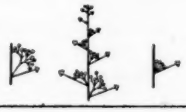
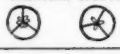
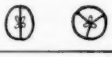
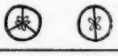
[4] Linnaeus, C. Genera Plantarum. ed. 1. 59. 1737.
[5] ———. Species Plantarum. ed. 1. 195–197. 1753.
[6] Kunth, C. S. in HBK. Nov. Gen. & Sp. Pl. 7:64. 1824.
[7] Wight, R. & Arnott, G. A. W. Prodr. Fl. Ind. Orient. 152. 1834.
[8] Bentham, G. & Hooker, J. D. Genera Plantarum 1:364. 1862–67.
[9] Exell, A. W., in Kew Bull. 1953:103. 1953.
[10] Loes. loc. cit. 2 Aufl. 20b:109. 1942.

	CELASTRUS	MAYTENUS	GYMNOSPORIA
HABITS	TWINERS	SHRUBS, SMALL TREES OR TREES	SHRUBS OR TREES
PHYLLOTAXY	ALTERNATE	ALTERNATE RARELY OPPOSITE	ALTERNATE
LENTICELS	DISTINCT	OBSCURE	OBSCURE
INFLORESCENCES	DISTINCT DICHASIA OR RARELY SOLITARY 	FASCICLED OR RARELY SOLITARY 	DISTINCT DICHASIA OR FASCICLED 
AXILLARY BUD AND BUD SCALES	DISTINCT 	OBSCURE 	OBSCURE 
FLOWERS	POLYGAMOUS RARELY BISEXUAL	BISEXUAL	BISEXUAL
ARTICULATION ON THE PEDICEL	DISTINCT 	NONE 	DISTINCT 
OVARY AND DISC	OVARY FREE FROM THE DISC, 3-CELLED; DISC USUALLY CUP-SHAPED, RARELY MERELY CONCAVE, MEMBRANOUS, RARELY SUBFLESHY 	OVARY SEMI-INMERSED IN THE DISC, USUALLY 2-CELLED, RARELY 3-CELLED; DISC FLESHY FLAT, RARELY CONCAVE 	OVARY SEMI-INMERSED IN THE DISC, USUALLY 3-CELLED, RARELY 2-CELLED; DISC FLESHY FLAT, RARELY CUP-SHAPED 
NO. OF OVULES IN EACH CELL	USUALLY 2 (1 IN CENTRAL AMERICAN SPECIES) 	USUALLY 2, RARELY 1 	ALWAYS 2 
FRUITS — SHAPE	SUBGLOBOSE, FURROWED 	ELLIPSOID OR OBOVOID, SMOOTH 	SUBGLOBOSE, ANGULAR 
FRUITS — NO. OF VALVES	3-VALVED 	USUALLY 2-VALVED, RARELY 3-VALVED 	USUALLY 3-VALVED, RARELY 2-VALVED 
FRUITS — NO. OF SEEDS	USUALLY 3–6-SEEDED, RARELY 1-SEEDED	USUALLY 1-SEEDED, RARELY 2–4-SEEDED.	USUALLY 3–6-SEEDED
SEEDS — SHAPE	USUALLY OVOID OR ELLIPSOID; ROUND IN CROSS-SECTION 	USUALLY OVATE; OVATE OR PLANO-CONVEX IN CROSS-SECTION 	USUALLY OVOID OR ELLIPSOID ROUND IN CROSS-SECTION 
SEEDS — ARIL	COMPLETE 	COMPLETE OR INCOMPLETE 	AT THE BASE OR INCOMPLETE 
ARIL OF THE OVULE	CUP-SHAPED ARIL 	NONE OR SLIGHTLY AT THE BASE 	NONE 
DISTRIBUTIONS	CHIEFLY IN ASIA, SOME IN AMERICA & MADAGASCAR	CHIEFLY IN S. & C. AMERICA FEW IN AUSTRALIA AND AFRICA	CHIEFLY IN S. AFRICA AND ASIA FEW IN PACIFIC ILS.

Celastrus Maytenus, and *Gymnosporia* contrasted.

Morphology

HABIT:—Plants of *Celastrus* are scandent, from 1 to 50 meters in height. The branches are hardy, rapid-growing and vigorous. There are very few available records of the diameter of older branches for all the species, but two records of *Celastrus monospermus* show this diameter to be about 10 cm. The branches and branchlets usually are terete, except in *Celastrus angulatus*, and are glabrous except on young branchlets, for example, of *Celastrus hirsutus*.

Most older stems have orbicular to ovate lenticels. In *Celastrus hindsii*, lenticels are usually absent on the current year's growth. They are fine and dense in *Celastrus angulatus* and *C. lenticellatus*, but in *C. hirsutus* and *C. cassariifolius* they are large, elevated, ovate, or orbicular, and are found on the peduncles and pedicels. This feature may well serve as a supporting character to assist in identification of some species.

VEGETATIVE BUDS:—*Celastrus gemmatus* bears axillary buds which are conical and characteristically large. All other species bear small, depressed and ovoid ones. The inflorescences of the species of series AXILLARES (except *Celastrus monospermus*, *C. monospermoides*, and *C. hindsii*) and one species of the subgenus RACEMOCELASTRUS, *C. panamensis*, are associated with accompanying vegetative buds, while the inflorescences of other species are not associated with vegetative buds. The outermost bud scales are usually deciduous, occasionally persistent, falcate, and spiny. These persistent bud scales are called "stipules" by some authors. Usually in *Celastrus aculeatus* and in some specimens of other species, there are four or more outermost bud scales as opposed to the usual two. These are nearly triangular, spiny, and semi-persistent or persistent.

LEAVES:—The leaves are extremely variable, in the same species, and even on the same plant, the result of environmental conditions and the age of the plant. Previous authors mainly have used leaf characters for distinguishing species and varieties in the genus, but such characters are very unreliable. Most of the species are deciduous, but there are evergreen ones, for example, *Celastrus monospermus*, *C. monospermoides*, and *C. hindsii*. The leaf shapes vary from elliptic to oblong, or from broadly ovate to orbicular. The apex and the base vary from acute to obtuse or rotund. The margins usually are serrate, serrulate or subentire; in *Celastrus flagellaris* they appear finely ciliate. In size, the leaves range from 2.0 cm. long and 0.8 cm. wide in *Celastrus punctatus* to 16 cm. long and 16 cm. wide in *C. angulatus*.

Texture usually varies from delicately to firmly membranous. In general, the texture of the leaves in flowering and fruiting stages of the plant is different: for example, in *Celastrus angulatus* the leaves of flowering specimens are delicately membranous, while those on the fruiting specimens are firmly membranous (so-called "coriaceous" of some authors).

The leaves are glabrous or pubescent on the veins below. Sometimes they are pubescent in the juvenile stage and later become glabrous. In *Celastrus hirsutus* there is a dense brownish pubescence on both surfaces.

The leaves of all the species have pinnate and netted veins. The midrib usually is elevated below, and distinctly or slightly elevated above. The primary lateral veins are four to nine pairs on each side of the midrib, arcuate towards the apex. The veinlets though usually visible, are obscure on both surfaces in *Celastrus aculeatus*, and while usually loosely reticulated are densely reticulated in *C. hindsii* and *C. gemmatus*.

The phyllotaxy always is alternate. The petioles are canaliculate, from 0.5 to 3.0 cm. long. In *Celastrus flagellaris* the petiole is half as long as the blade while in the other species it is less than half as long.

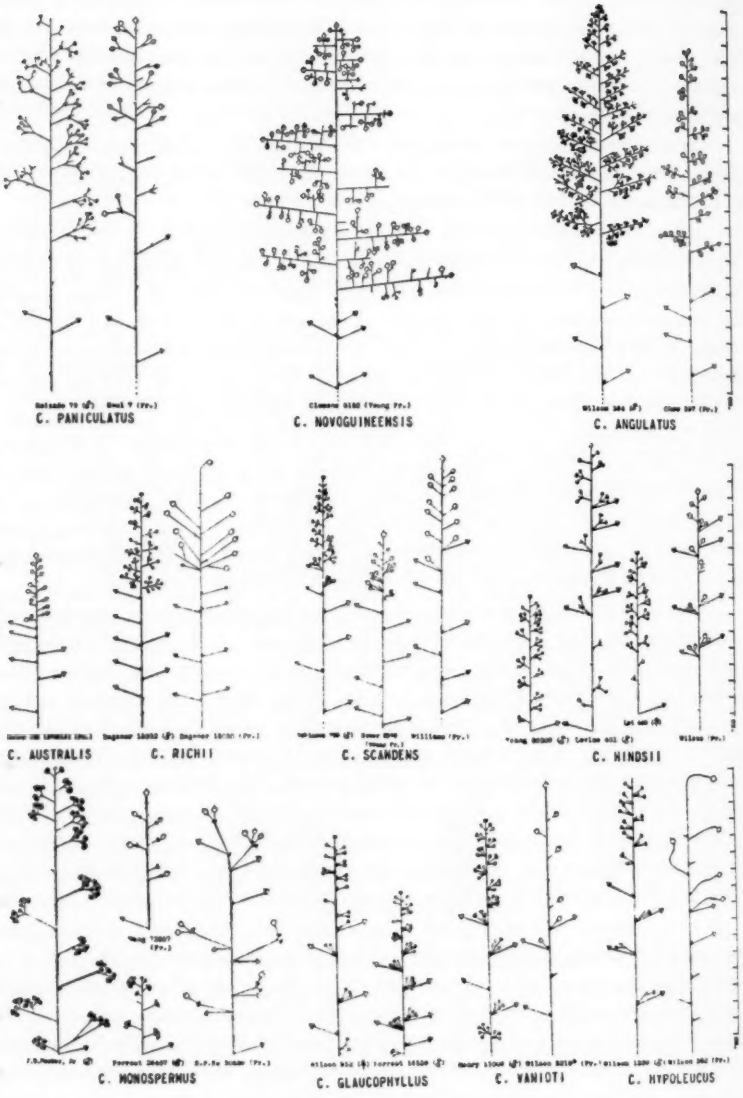
FLORIFEROUS BRANCHES AND INFLORESCENCES:—Diagrams of the *floriferous branches of the current season's* or *year's growth* of most of the species of *Celastrus* have been drawn from herbarium specimens (pls. 32 and 33). These diagrams are arranged according to the sequence of the species in the key, and are not intended to show any evolutionary paths. They will make it convenient for a comparison of the relationships among the species. They also reveal that the male and female plants of the same species have different inflorescence patterns.

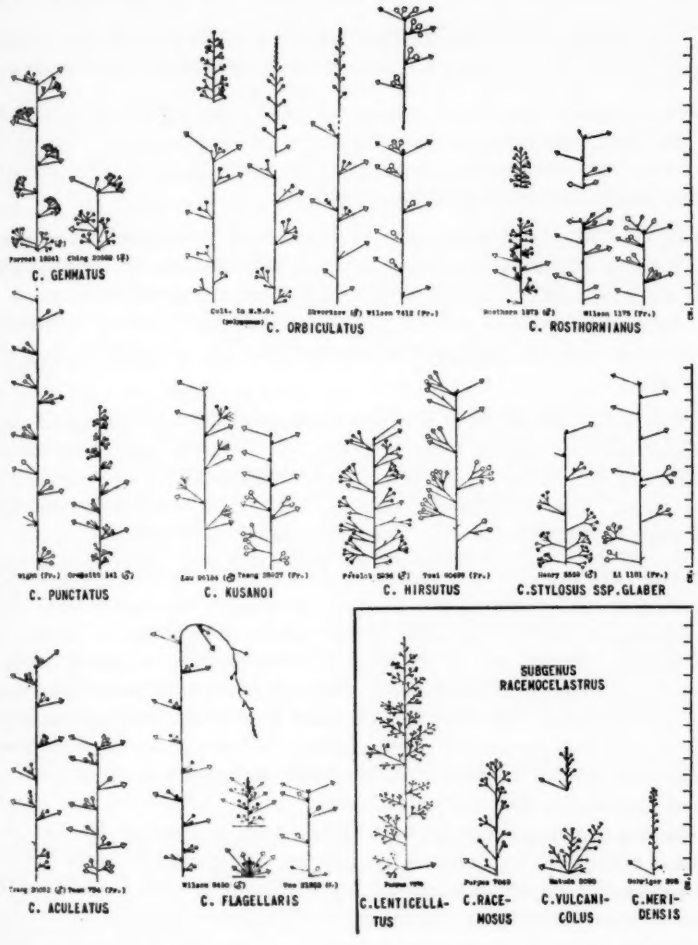
A "flower-cluster" has been thought of as a whole inflorescence or as a part of the inflorescence. Parkin[11] has commented: "It seems futile to quibble over the question whether the inflorescence means the mode of floral branching or the flower-group itself. Custom has sanctioned the latter meaning." I have adopted the customary approach of considering a "flower-group" as an inflorescence only as a matter of convenience in this treatment of the genus *Celastrus*.

Dichasium and Aggregate Dichasium:—The fundamental type of inflorescence in the genus *Celastrus* is an axillary, solitary dichasium. A dichasium in its simplest form consists of three flowers—one terminal and two lateral, the terminal flower blooming first—and is organized as follows: First, there is the primary peduncle terminating in three secondary peduncles to each of which the pedicels of the flowers are articulated. What appears at first to be the entire flower stalk therefore is really a part of the peduncle and the whole pedicel. The dichasium usually is compound, and sometimes the branches are much multiplied to form a terminal paniculiform aggregate dichasium. The aggregate dichasium differs from the thyrse in all axes being determinate and lacking any association with vegetative buds. In the literature the paniculiform floriferous branches are described usually as "panicles."

Each dichasium may or may not be subtended by a foliage leaf or bract, but in the series AXILLARES it is always associated with a dormant bud in the axil of the subtending appendage (pls. 31 and 32). All the species of subgenus RACEMOCELASTRUS have axillary dichasia with or without distinct primary peduncles. The Latin American species of RACEMOCELASTRUS, in addition, usually have dichasia arranged to form a racemiform floriferous branch on the current year's growth (pl. 33). In this case the racemiform branch may be compounded and be located terminally on the branchlets to form a pseudopaniculiform aggregate dichasium

[11] Parkin, J. The evolution of the inflorescence. Jour. Linn. Soc. Bot. 42:512–563. 1914.


C. PANICULATUS
C. NOVOGUINEENSIS
C. ANGULATUS
C. AUSTRALIS
C. RICHII
C. SCANDENS
C. HINDSII
C. MONOSPERMUS
C. GLAUCOPHYLLUS
C. VANIOTI
C. HYPOLEUCUS



- axillary bud
- floral bud
- blooming flower
- fruit
- bract
- leaf

Plates 32 and 33. Diagrams of the floriferous branches of current season's or year's growth of *Celastrus* species.

(pl. 33). This type of dichasium differs from the paniculiform aggregate dichasium in series PANICULATI in having a vegetative bud in the axil of each dichasium.

FLOWERS:—The flowers of this genus are small and inconspicuous, usually about 3–5 mm. long. According to the available records the flowers are yellowish-green or white. They are generally dioecious in the subgenus CELASTRUS, and usually bisexual in the subgenus RACEMOCELASTRUS.

Calyx:—The calyx is campanulate and persistent, and sometimes accrescent as in *Celastrus aculeatus*. It always has five short and equal, deltoid, ovate, or oblong lobes which are usually imbricate or in some species rarely open in aestivation. The lobes have simple venation and are glandular-ciliate, slightly erose, or entire; they are glabrous or slightly pubescent on the outer surface, and reflexed or spreading in the fruit.

Petals:—The flowers have five petals which usually are oblong or elliptic, glandular-ciliate to slightly erose, or entire. In *Celastrus paniculatus* the petals have parallel veins while in other species each of the petals has a "costa" and some lateral veins. They are generally glabrous, but in *Celastrus kusanoi* are slightly puberulent on the inner surface. The petals usually are reflexed.

Floral Tube and Disc:—In the flower, there is a cup-shaped or plate-like structure which is usually referred to as the disc. Berkeley[12], who made a morphological and anatomical study of the flower of two species of *Celastrus, C. scandens* and *C. orbiculatus,* on the basis of the behavior of the vascular supply to the flower, interpreted the cup-shaped structure as the floral tube consisting of fused stamen, petal, and sepal bases. He considered the inner layer of the floral tube to be composed of fused basal portions of existing stamens and of stamens no longer present; between the existing stamens, there are small projections of tissue of reduced stamens constituting the "disc" in his sense.

The cup-shaped and membranous "floral tube" is common in most of the species in this genus. It surrounds the pistil but is free from it; on the rim of the tube are attached the free floral parts. A plate-shaped, flat and fleshy "floral tube" is usually present, chiefly in all the species of subgenus RACEMOCELASTRUS and several other species of the subgenus CELASTRUS. The ovary is situated at the center of this type of "tube" and free from it, while all the floral parts are attached on the outer edge of the tube. The two species that Berkeley had studied lacked the flat floral tube, and it is difficult to interpret its origin without morphological and anatomical evidence.

The term disc connotes the "floral tube" of Berkeley, and disc-lobe is equivalent to the "disc" in Berkeley's sense in the present treatment of *Celastrus;* this is just for convenience. The disc-lobe may be distinct or obscure, deltoid, oblong or reniform. Sometimes these are used as supporting characters to identify species.

[12] Berkeley, E. Morphological studies in the Celastraceae. Jour. Elisha Mitchell Scientif. Soc. 70:185–206. 1954.

Fertile and Sterile Stamens:—There are five stamens in the staminate flowers. The stamens depart from the rim of the cup-shaped disc, or are attached immediately beneath the edge of the flat disc. The filaments generally are filiform, fleshy or thin. They are glabrous in all of the species except *Celastrus stylosus* ssp. *stylosus*, *C. aculeatus*, *C. hirsutus*, and *C. kusanoi*, where they are papillose-tuberculate. The filaments usually are longer than the anther, but in *Celastrus novoguineensis* they are shorter. The anthers in the staminate flowers are generally oblong-ovoid, obtuse or cordate, but in some species they are distinctly apiculate, i.e., *Celastrus pringlei*. The sterile stamens in the pistillate flowers are small, short, and about 1 mm. long; the anthers of these are triangular and cordate, and sometimes they may contain sterile pollen grains.

Fertile and Sterile Pistils:—The fertile pistil usually is superior and free from the disc. The ovary usually is subglobose or ovoid, and narrowed into a columnar style. The ovary has three cells. Each cell has two ovules in the species of subgenus CELASTRUS while there is only one ovule per cell in the species of subgenus RACEMOCELASTRUS. The stigma is trilobed or the lobes are obscure. In some species the lobes are further divided in half, for example, *Celastrus orbiculatus*. The lobes usually are filiform and reflexed, but they are tangentially flattened in *Celastrus angulatus*. The sterile pistil in the staminate flowers usually is small and columnar.

Ovules:—The ovules are anatropous and attached at the base of the ovary by a distinct funiculus. The raphe is clearly visible on the seed. In a free-hand section of the ovule the micropyle is sometimes visible towards the base. The ovule has the characteristic cup-shaped aril towards its base, which is a definitive character of this genus.

The embryo is erect, thin-foliate and broadly spatulate[13]. The radicle is cylindric and stalk-like.

FRUITS:—Fruits are subglobose, ovoid, obovoid or cylindric, and are smooth, or rarely angular as in *Celastrus monospermoides*. The bases of the fruits are obtuse or rotund, except in *Celastrus monospermus*, where the base is contracted into a column and is stalk-like. The fruits generally have three cells, but two- or four-celled fruits are occasionally found on some plants. The fruits are three- to six-seeded in most of the species. *Celastrus monospermus*, *C. hindsii*, and *C. monospermoides* have only one developed seed with five undeveloped ovules, while all the species of the subgenus RACEMOCELASTRUS have one developed seed with two undeveloped ovules. The fruit is three-valved, dehiscence being loculicidal. The valves are bright yellow or dark brown, slightly transversely wrinkled on the outside, and spreading or reflexed in dehiscence.

[13]Martin, A. C. The comparative internal morphology of seeds. Amer. Midl. Nat. 36:520, *fig. 2, pl. 55*. 1946.

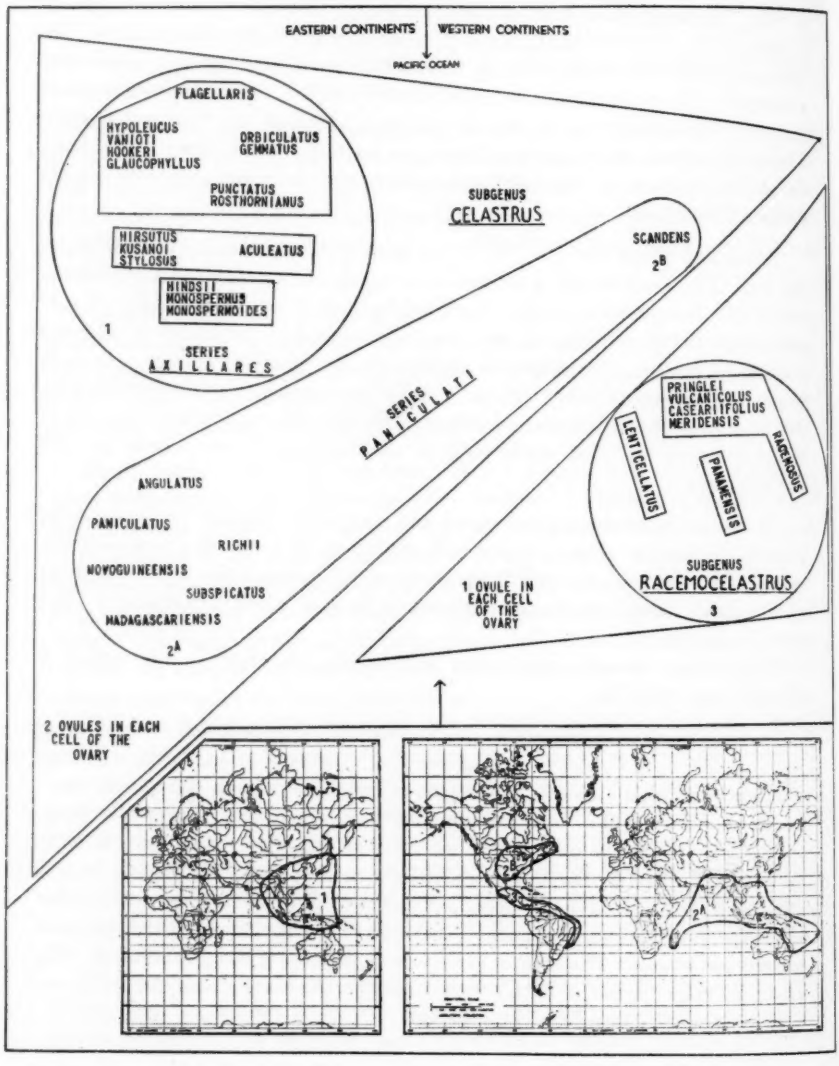


Fig. 1. Chart showing interrelationship of species of *Celastrus* and their geographical distribution.

Harris[14] studied the relationship between the number of flowers formed and the number of fruits maturing per inflorescence in *Celastrus scandens*. He also studied the size of an inflorescence as measured by the number of flowers it produces and the number of seeds per fruit. His conclusion is that there is no correlation between these pairs of characters.

Geographical Distribution

Celastrus is widely distributed in eastern Asia, Oceania, both Americas and Madagascar, between the latitudes of about 40° S. and 47° N. Most of the species are found in the subtropical and tropical zones. From the distribution patterns of the species, it appears that there are two centers of dispersal: Yunnan-Burma-eastern India, and Central America (fig. 2).

In eastern Asia, the species radiate from the Yunnan-Burma-eastern India region. *Celastrus paniculatus*, one of the two most widely distributed species, radiates from that region eastward through Kwangsi, Kwangtung, and Hainan, eastward to Formosa; southward through the Malay Peninsula to Indonesia and then northward to the Philippines, and westward to India and Ceylon. *Celastrus hindsii*, the other widespread species, extends from the center westward to Sikkim; northeastward through Yunnan and Kweichow to Szechuan and Hupeh; eastward to Kwangtung, Fukien, Formosa and Bonin Islands, Japan; and southward through the Malay peninsula to Indonesia. The other species of that area have much more restricted distributions. From the Asiatic center of dispersal, the number of species gradually decreases both northward and southward, as is shown on the distribution map (fig. 2).

In North America there is only one species, *Celastrus scandens*. It is widely distributed forming an ellipse from Quebec southward to Virginia, then westward to Texas and eastern Wyoming. It is closely related to the Asiatic species of the series PANICULATI.

The disjunct distribution and floristic relationship of plants of eastern Asia and eastern North America recently have been interpreted by Li[15]. He says that this familiar disjunct distribution appears to be the remnants of great mesophytic forests that extended over all the northern hemisphere and reached the arctic regions in the Tertiary period. Geological changes have destroyed and changed the floras of many lands so that this mesophytic forest of the Tertiary times in the northern hemisphere survives mainly in eastern Asia and eastern North America.

Berry[16] states: "The genus *Celastrus* Linn. is the largest fossil genus of the family. Though its present center of distribution lies in the upper lands of south-

[14] Harris, J. A. Correlation in the inflorescence of *Celastrus scandens*. Mo. Bot. Gard. Ann. Rept. 20:116–122. 1909.

[15] Li, Hui-lin. Floristic relationships between eastern Asia and eastern North America. Trans. Amer. Philos. Soc. 42:371–429. 1952.

[16] Berry, E. W. The Lower Eocene flora of southeastern North America. U. S. Geol. Surv. Prof. Paper 91:105. 1919.

eastern Asia and East Indies, its history shows that the ancestral stock was cosmopolitan and very abundant in the Tertiary of America and Europe. It is highly probable that it originated in America at the dawn of the Upper Cretaceous or somewhat earlier." Croizat[17] says that this view cannot be accepted as it is in conflict with the distribution data, but he cites no alternative center. All that can be said from present distribution patterns is that *Celastrus scandens* is related to the eastern Asiatic center of dispersion rather than to the one in Central America.

It is rather difficult to interpret the relationships of the Central and South American species. Loesener[18] has pointed out that the Latin American species show relationship with tropical Asiatic species. They closely resemble the Asiatic species *Celastrus monospermus*, *C. monospermoides*, and *C. hindsii*, especially in their inflorescence patterns, discs, and one-seeded fruits; but differ in the number of ovules

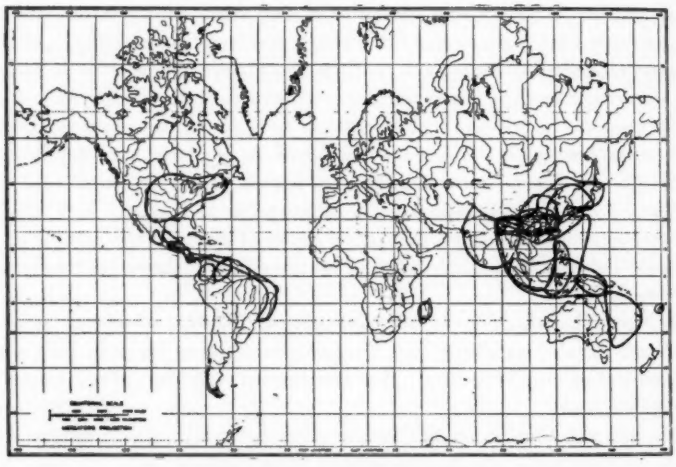


Fig. 2. Distribution patterns of *Celastrus*

All the maps used in this paper are from Goode's Series of Base Maps, University of Chicago Press, except the map of the United States, which was kindly furnished by Dr. Woodson.

in each cell of their ovaries and in their sexuality. In the Central and South American species there is only one ovule in each ovary cell, while in all the other species the ovary cells have two ovules; the Asiatic and North American species are dioecious while the Latin American species are bisexual.

Croizat[19], in his studies of the intercontinental distribution of plants, mentions that some Asiatic genera "run a transpacific channel [sic!]" from the Far East to

[17] Croizat, Leon. Manual of Phytogeography. p. 302. 1952.
[18] Loes. loc. cit. 20b:103. 1942.
[19] Croizat, Leon. loc. cit. pp. 54, 305, and *fig. 16*. 1952.

the New World. He holds the celastraceous genus *Perrottetia* as a perfect example. There are about fifteen species of this genus distributed in Queensland, New Guinea, Moluccas, Celebes, Philippines, northern Borneo, Formosa, central China, Hawaii, Mexico, Colombia, and Venezuela, and every essential station in the "traject [sic!]" is exemplified by one or more species.

An alternative hypothesis is suggested by the fact that the Latin American species of *Celastrus* constitute a distinct subgenus without representatives in the Eastern Hemisphere. These species appear to be closely related to the neighboring genus *Maytenus*, which includes species of both Latin America and Africa, a distributional phenomenon which might be explained upon the hypothesis of trans-Atlantic continental drift. From a rather dogmatic view of phylogeny, one might assume the hermaphroditic flowers of *Maytenus* (as well as of *Gymnosporia*) to be "primitive" from which the bisexual condition general for the Latin American *Celastrus* might be derived. The North American *Celastrus scandens* is closely related to the species of the Eastern Hemisphere rather than to those of the Western Hemisphere, thus suggesting that the North American and Latin American *Celastrus* might have different origins. The two subgenera perhaps therefore can be said to have independent origins.

Hybridization

White and Bowden[20] have reported identical chromosome numbers ($n = 23$) for the American *Celastrus scandens* L. and the Asiatic *C. orbiculatus* Thunb. They were able to hybridize these species with interesting results. The hybrid is less vigorous than the parents and sparingly fertile; the fruits are smaller than those of either parent, and the seeds are not uniform in size. When they back-crossed the hybrid to both parents both the F_2's had leaves closely resembling those of *Celastrus scandens*. The plants resulting from the back-cross to *Celastrus orbiculatus* yielded one-seeded fruits, with only two exceptions among the 475 fruits produced, while the fruits of both parent species contained three to six seeds. Of the plants resulting from those back-crosses, there is no further record available regarding the inflorescences, the sexuality of the flowers, the ovule number in each cell of the ovary, and the sizes and shapes of the seeds.

All the Latin American *Celastrus* species have one-seeded fruits. It would be interesting to learn the chromosome number and morphology in these species. Since the Latin American species are more or less an uniform and isolated group, cytological data might help in relating them to other groups of the genus *Celastrus*.

In *Celastrus*, there appears to be a strong possibility of hybridization taking place in nature in certain localities. For example, *Celastrus vanioti* looks like a hybrid between *Celastrus angulatus* and *C. hypoleucus*. A specimen collected by *Wang 76880* from Yunnan, China, seems a hybrid between *Celastrus hindsii* and *C. monospermus*.

[20] White, O. E., and Bowden, W. N. Oriental and American bittersweet hybrids. Jour. Hered. 38:125–127. 1947.

Economic Uses

There are very few available records of economic uses of *Celastrus*. Two species, *Celastrus scandens* and *C. orbiculatus*, are widely cultivated commercially for their beautiful yellowish fruits which open at maturity and disclose the crimson arillate seeds.

Balfour[21] states that the bark of *Celastrus scandens* has emetic and purgative properties. The seeds of this species are said[22] to be useful pharmaceutically. An oil is extracted from the seeds of *Celastrus paniculatus*, which is described as having a very hot and bitter taste. It *(oleum nigrum)* is useful for burning[23] and has been employed in India successfully in treating beriberi disease[24]. Burkill[25] reports that in Malaya the seeds may be used, externally, in poultices, or in the Philippines, internally, as an anti-rheumatic and as a treatment of paralysis. In Java, the leaves are used in dysentery. In the Philippines, the sap is given as an antidote in opium-poisoning.

Hemsley[26], quoting from A. Henry's record, states that the leaves and roots of *Celastrus latifolius* Hemsl. (= *C. angulatus* Maxim.), when dried in the sun and pounded to a powder, are efficient in killing insects infesting turnips and other vegetables in China.

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[21] Balfour, J. H. Class Book of Botany. p. 794. 1882.
[22] Gray, Asa. The Genera of the Plants of the United States. 2:185. 1849.
[23] Lawson, G. in Trans. Bot. Soc. Edinburgh 6:364. 1860.
[24] Voigt, J. O. Hortus suburbanus Calcuttensis. A Catalogue of the Plants which have been cultivated by the Hon. East India Company's botanical garden, Calcutta, etc. p. 166. 1845.
[25] Burkill, I. H. A Dictionary of the Economic Products of the Malay Peninsula. 1:505. 1935.
[26] Hemsley, W. B. in Jour. Linn. Soc. Bot. 23:124. 1886–88.

Abbreviations

Herbarium specimens used in this study include those of the following herbaria or institutions. The abbreviations for them are taken from Lanjouw & Stafleu's 'Index Herbariorum', part I (Regnum Vegetabile, vol. 2, 2nd. ed., 1954).

A—Arnold Arboretum, Harvard University, Cambridge, Massachusetts.
BLAT—Blatter Herbarium, St. Xavier's College, Bombay, India.
BKL—Herbarium of the Brooklyn Botanic Garden, Brooklyn, New York.
CAL—Indian Botanic Garden, Howrah, Calcutta, India.
F—Chicago Natural History Museum, Chicago, Illinois.
GH—The Gray Herbarium of Harvard University, Cambridge, Massachusetts.
HK—Herbarium, Gardens Department, Hongkong, China.
K—The Herbarium, Royal Botanic Gardens, Kew, England.
L—Rijksherbarium, Leiden, Netherlands.
MICH—University Herbarium, University of Michigan, Ann Arbor, Michigan.
MO—Missouri Botanical Garden, St. Louis, Missouri.
NY—New York Botanical Garden, New York, N. Y.
P—Museum National d'Histoire Naturelle, Laboratoire de Phanérogamie, Paris, France.
PENN—Herbarium of the University of Pennsylvania, Philadelphia, Pennsylvania.
PH—Academy of Natural Sciences, Philadelphia, Pennsylvania.
S—Naturhistoriska Riksmuseum, Botanical Department, Stockholm, Sweden.
SING—Herbarium of the Botanic Gardens, Singapore, Malaya.
TAI—Herbarium, National Taiwan University, Taipei, Taiwan, China.
U—Botanical Museum and Herbarium, Utrecht, Netherlands.
UC—Herbarium of the University of California, Berkeley, California.
UPS—Institute of Systematic Botany, Botanical Garden and Botanical Museum of the University of Uppsala, Uppsala, Sweden.
US—National Museum, Smithsonian Institution, Washington, D. C.

Taxonomy

Celastrus L. Gen. Pl. ed. 1. 59. 1737; Sp. Pl. ed. 1. 196. 1753; Gray, Gen. Pl. U. S. 2:185, *pl. 170.* 1849; Benth. & Hook. Gen. Pl. 1:364. 1862; Loes. in Engl. & Prantl, Nat. Pflanzenfam. 2 Aufl. 20b:131. 1942. (Type species: *C. scandens* L.).

Euonymoides Isnard, ex Medicus, Philos. Bot. 1:173. 1789 *(pro parte).*
Celastrus § *Eucelastrus* Wight & Arn. Prodr. Fl. Ind. Orient. 158. 1834.
Semarilla Raf. Sylva Tellur. 146. 1838. (T.: *S. bicolor* Raf.).

Scandent shrubs, up to 50 m. tall; branches usually terete, rarely the branchlets angular, usually glabrous, rarely pubescent, scarcely to densely lenticellate. Leaves extremely variable, elliptic to orbicular, serrate or subentire, rarely finely ciliate-serrulate, deciduous, rarely evergreen, alternate, petiolate; stipules small, usually laciniate and deciduous. Inflorescences dichasia, paniculiform to racemiform, solitary, sometimes branched, axillary or terminal, pedunculate or sessile, few- to many-flowered. Flowers small, usually unisexual and dioecious, rarely bisexual, pedicellate and articulate. Calyx campanulate, persistent on the fruits, 5-lobed; petals oblong, obovate-oblong or ovate, glandular-ciliate to erose, or entire, inserted under the disc, alternate with the calyx lobes; disc usually membranous and cup-

shaped, or fleshy and flat, entire or 5-lobed, the lobes alternate with the stamens; stamens 5, the filaments glabrous or papillose-tuberculate, arising from the margin of the disc proper or attached immediately beneath it, the anthers ovoid or oblong-ellipsoid, obtuse or apiculate, dehiscing laterally or extrorsely, dorsifixed, versatile, the thecae separated at the lower half or third; ovary superior, subglobose or ovoid, free from the disc or rarely slightly confluent with it, 3-celled, each 2-ovuled (subgen. CELASTRUS) or 1-ovuled (subgen. RACEMOCELASTRUS), the ovules arising from the base of the ovary, axile, anatropous, with a cup-shaped aril towards its base, sessile or with a short funicle, the style usually columnar, the stigma usually 3-lobed or the lobes obscure, rarely each bifid. Fruit a capsule, usually subglobose, rarely cylindric, tipped by the persistent style, 3-celled, dehiscence loculicidal, 3-valved, the valves terminating in part of the style, 1- to 6-seeded; seeds enclosed in a fleshy crimson aril, the areolae distinct or obscure, the albumen copious, the embryo erect, thin-foliate and broadly spatulate.

KEY TO THE SUBGENERA AND SERIES

A. Flowers unisexual and dioecious; ovary 3-celled, each cell 2-ovuled; fruits 3- to 6-seeded, or in some species 1-seeded with 5 distinctly undeveloped ovules. Asia, Oceania, Madagascar, and North America.....Subgen. I. CELASTRUS
  B. Inflorescences usually terminal only, or, if in the axils of the uppermost leaves as well, without accompanying vegetative buds.....Ser. 1. PANICULATI
  BB. Inflorescences both terminal and axillary, or axillary only, but the axillary always with accompanying vegetative buds (except in *C. monospermus*, *C. monospermoides*, and *C. hindsii*).....Ser. 2. AXILLARES
AA. Flowers bisexual; ovary 3-celled, each cell 1-ovuled; fruits 1-seeded with 2 distinctly undeveloped ovules. Central and South America.....Subgen. II. RACEMOCELASTRUS

Subgenus I. CELASTRUS

Series 1. PANICULATI Rehd. & Wils. in Sarg. Pl. Wils. 2:354. 1915.

KEY TO THE SPECIES

A. Calyx lobes imbricate, broader than long.
  B. Inflorescences usually at least thrice compound; petioles usually more than 10 mm. long.
    C. Anthers of the male flowers truncate at the apex, with distinct filaments about 1 mm. long; pistil of the female flower about 2.5 mm. long, the style half as long as the ovary. India, Burma, Siam, Indo-China, China, Malaya, Indonesia, and the Philippines.....1. *C. paniculatus*
    CC. Anthers of the male flowers apiculate, sessile or subsessile; pistil of the female flower about 1.5 mm. long, the style about one-fourth as long as the ovary. New Guinea.....2. *C. novoguineensis*
  BB. Inflorescences once or twice compound; petiole less than 10 mm. long.
    D. Anthers of the male flowers not apiculate or obscurely so; stigmata distinctly 3-lobed; disc-lobes truncate; inflorescences usually 3–9 cm. long.
      E. Fruiting pedicels 1–3 mm. long; leaves firmly membranous. Eastern Australia, Papua, and New Caledonia.....3. *C. subspicatus*
      EE. Fruiting pedicels 4–12 mm. long; leaves thinly membranous. Fiji.....4. *C. richii*
    DD. Anthers of the male flowers apiculate; stigmata discoid or slightly 3-lobed; disc-lobes cuspidate; inflorescences 1–3 cm. long. Madagascar.....5. *C. madagascariensis*
AA. Calyx lobes open, longer than broad.
    F. Young branchlets angular; leaves orbicular or broadly ovate, the petioles of upper leaves usually more than 2 cm. long; inflorescences usually more than 10 cm. long, dense, many-flowered; disc fleshy, flat; fruits subsessile. China.....6. *C. angulatus*

FF. Young branchlets terete; leaves elliptic or broadly elliptic, the petioles of upper leaves usually less than 1.6 cm. long; inflorescences usually less than 8 cm. long, lax, relatively few-flowered; disc membranous, cup-shaped; fruits pedicellate, the pedicels 2–5 mm. long. North America.....*7. C. scandens*

1. CELASTRUS PANICULATUS Willd. Sp. Pl. 1:1125. 1797 (as *paniculata*); Lawson in Hook. Fl. Brit. Ind. 1:617. 1875, ex char.

Scandent shrubs up to 10 m. tall; branches terete, glabrous, brown, the young branchlets terete, usually pubescent, densely lenticellate, the lenticels elliptic, sometimes elevated; axillary buds deltoid to orbicular, about 1.5 mm. long. Leaves elliptic, obovate, suborbicular, broadly ovate, ovate-oblong to oblong, the apex abruptly acute, obtuse or rarely emarginate, the base cuneate, broadly acute to obtuse, the margins serrate or remotely crenate, 5–15 cm. long, 2.5–6.0 cm. wide, firmly membranous, glabrous, sometimes pubescent on the veins below, the primary lateral veins usually 5–7 pairs, elevated on both surfaces, curved toward the apex, the veinlets distinct to slightly elevated below, immersed but visible above; stipules laciniate, about 1 mm. long; petioles 0.5–1.5 cm. long. Inflorescences terminal, paniculiform, thrice- to multi-compound, spreading, usually 5–10 cm. long, rarely up to 20 cm. long, pedunculate, the peduncles glabrous or puberulous, the primary peduncles usually 6–10 mm. long; flowers dioecious, pale or yellowish green, the pedicels about 4–6 mm. long, the articulation at the basal part of the stalk. Male flowers: calyx lobes semi-orbicular, imbricate, ciliate, about 0.7 mm. long and 1.5 mm. wide; petals oblong or obovate-oblong, obtuse, entire, about 3 mm. long and 1.5 mm. wide, with parallel veins; disc cup-shaped, the lobes inconspicuous, slightly triangular; stamens arising from the margin of the disc proper, 3 mm. long, the filaments subulate, flat, glabrous, the anthers ovoid, obtuse, cordate; sterile pistil columnar, about 1.3 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens 1.3 mm. long; pistil 2.5 mm. long, the ovary globose, the style columnar, the stigmata 3-lobed, each deeply bifid, slender. Fruits subglobose, the valves broadly elliptic, about 6–9 mm. long and 5–8 mm. wide, 3- to 6-seeded; seeds ellipsoid, 3.5–5.0 mm. long and 2–5 mm. wide, yellowish-brown, smooth.

Chiefly in thickets, at altitudes from 200 to 1,800 m.; widely distributed in India, Burma, Siam, Indo-China, China, Malaya, Indonesia, and the Philippines; flowering from April to June.

KEY TO THE SUBSPECIES

A. Leaves orbicular to broadly ovate.
  B. Leaves orbicular, suborbicular, or obovate. India, Ceylon, Burma, Indo-China and southwestern China .....1a. ssp. *paniculatus*
  BB. Leaves broadly ovate. Philippines and Indonesia.....1b. ssp. *serratus*
AA. Leaves elliptic to elliptic-oblong. India, Burma, Siam, Malay, Indonesia, Palawan Isl. (Philippines), and China .....1c. ssp. *multiflorus*

1a. CELASTRUS PANICULATUS ssp. PANICULATUS.

Celastrus nutans Roxb. Hort. Beng. 18. 1814, nom. nud.; Fl. Ind., ed. Carey & Wall. 2:390. 1824, ex char.

Celastrus rothiana Roem. & Schult. Syst. 5:423. 1819; DC. Prod. 2:8. 1825, ex char. (T.: *Heyne s. n.*).

Ceanothus paniculatus Heyne ex Roth, Nov. Pl. Sp. 154. 1821, ex char.
Scutia ? paniculata G. Don, Gen. Syst. 2:34. 1832, ex char.
Celastrus pubescens Wall. Cat. 4303. 1831, nom. nud.
Celastrus metzianus Turcz. in Bull. Soc. Nat. Mosc. 31:448. 1858. (T.: *Metz 1549*, GH!).
Celastrus paniculatus var. *pubescens* Kurz ex Prain, in Jour. Asiat. Soc. Bengal 73:196. 1904, nom. nud.
Celastrus paniculatus var. *andamanica* Kurz ex Prain, loc. cit. 73:196. 1904, nom nud.

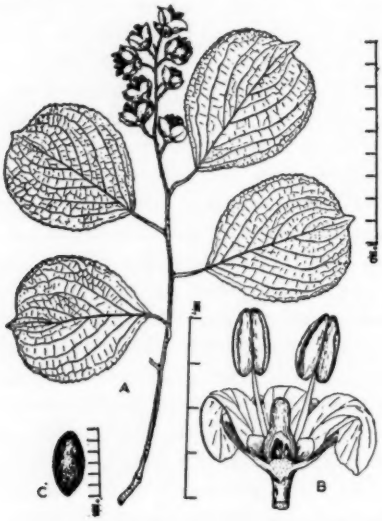

Fig. 3. *Celastrus paniculatus* ssp. *paniculatus*

BURMA: Fort Stedman, *Abdul Khalil s. n.*, 1894 (CAL); *Dr. King's collector 454* (CAL), *479* (L); Cokteih Shaub, *Meebold 8055* (S); Maymyo Hill, *Badal Khan 36, 259* (CAL); Maymyo Plateau, *Lace 3130, 3280* (CAL); Pegu, *Eyre s. n.*, 1887 (CAL), *Kurz 1926* (CAL); SHAN HILLS: Keloh, *Collett 588* (CAL), Pwehla, *Collett 672* (CAL); Shwebo, *Abdul Huk 62* (CAL); SOUTHERN SHAN STATE: Laikow, *Abdul Khalil s. n.*, 1893 (CAL), *s. n.*, 1894 (CAL), Taungyi, *Abdul Khalil s. n.*, 1893 (CAL), *s. n.*, 1894 (CAL, L, UPS); Yeu, *Cole s. n.*, 1890 (CAL).

CEYLON: Rewamb, *Watson 176* (CAL); without precise locality, *Thwaites 1232* (CAL).

CHINA: YUNNAN: Che-li, *Wang 75551, 76335* (A); Fo-hai Hsien, *Wang 74570, 74650* (A); Nan-chiao, *Wang 75024* (A); Shung-kiang Hsien, *Wang 72996* (A); Lang-tsang Hsien, *Wang 76644* (A); Szemeo, *Henry 11572* (US).

INDIA: ASSAM: Khasia Hills, 1,000–3,000 ft., *Hooker & Thompson s. n.* (CAL, L, S, U), Duphla Hills, Radhu, Pokri, *Lister s. n.* (CAL); Andamann's, *Dr. King's collector s. n.*, Aug. 2, 1891 (CAL), *Dr. Prain's collector 70, 78* (CAL). BENGAL: Lower Bengal, *Kurz s. n.* (CAL); Darjelling, Reyang, *Osmaston s. n.*, Nov. 25, 1903 ((CAL), Manbhum, *Campbell s. n.* (CAL); Maymbhing, Baripada, *Hooper 38801* (CAL), Orissa, *Ball s. n.*, April 26, 1896 (CAL); Pachete, *Kurz s. n.* (CAL). BIHAR STATE: Chota-Nagpur, Parasnath, *Clarke 24857* (CAL); Chota Nagpur, Palamow, in Kumandi Reserve, *Gamble 8780* (CAL); Golah, Hazaribagh, Chota Nagpur, *Prain s. n.*, Nov. 29, 1891 (CAL); Parasnath, *Kurz s. n.* (CAL); Rajmahal Hills near Sahebganj, *Kurz s. n.*, May 1867 (CAL); Topechana, *Kurz 65* (CAL). BOMBAY STATE: vic. Concan, *Stocks s. n.* (CAL, L, S. U, UC, UPS); Khandala, *Santapau S. J. 12707* (MO); Poona, Deccan, *Woodrow*

s. n., 1882 (CAL); Dharasu, *Dudgeon & Kenoyer 237* (MO); Bhawani, in montibus Nilagiricis, *Metz 1549* (type of *Celastrus metzianus* Turcz., UPS). HIMALAYA: Bhim-Tal, Kumao, *Strachey & Winterbottom 2* (CAL); Kalidungi, *Thomson 740* (CAL); Lachinwala, *Nai Sanon Samnasena 34* (CAL); Pattludon, *Brandis 2032* (CAL); Raipur, *Clarke 23681*[B] (CAL); Kalsi & Asarori, *Amar Nath 24* (A); hills northwest of Kendat, *Prazer 273* (CAL); Madhyapradesh, *King s. n.* (CAL). MADRAS STATE: Ganjam, Pralugaon, Chilka Lake, *Hooper 39537* (CAL); Godairi, Chodavarum, *Ramaswami 1490* (CAL); Naikeneri, Palmaner-chittur, *Fischer 4739* (CAL); Rambba, *Narayanaswami 105* (CAL), MADHYA PRADESH: Gwalior, *Maries 22* (CAL); Khandwa, *Duthie 8211* (CAL). MYSORE: Somanathapur, *Barber 6846* (CAL); Shimoga, *Barber 7018* (CAL); Bettiah, near the Nepal frontier, *Hieronymus 443* (CAL). HYDERABAD: Jalna, Peninsular India, *Rodriguez 2025* (CAL). PUNJAB: Bhadwar, Kangra, *Koelz 4266* (MICH, US), *4377* (MICH, UC, US); Gurdaspur Distr., *Bis Ram 309* (S); Karnal Distr., *Drummond 21651, 21691* (UC); Kasauli Hills, *Drummond 21515* (UC); Kasansi, *Drummond 21516* (UC); Lachhiwala, *Revoti Mohon Mukherjee 32* (US). TRAVANCORE COCHIN STATE: Shencotah to Aryan Karn, *Calder & Ramaswami 654* (CAL); Nokara, *Rama Rao 1588* (CAL). SIKKIM: Garubathen, *Dr. Prain's collector s. n.*, 1,500 ft. alt., 1900 (CAL); Rungit, *Clarke 26330* (CAL); without precise locality, alt. 2,000–4,000 ft., *Hooker s.n.* (CAL, L). RAJASTHAN: Abu, *King s. n.* (CAL), *Stocks 231* (CAL). UTTAR PRADESH: Dehra Dun, *Pradhan 34* (S); Piujour & Dehra Dun, *Anrudh Singh 25* (S), *Vicary (?) 175* (CAL); Upper Gangetic plain, *Harsukh 21400* (UC), Dehra Dun, *Mackinnon s. n.* (CAL); *Singh 43* (UC).

INDO-CHINA: Cambodia, *Pierre 895* (L).

1b. CELASTRUS PANICULATUS ssp. **serratus** (Blanco) Ding Hou, stat. nov.

Diosma serrata Blanco, Fl. Filip. 168. 1837; ed. 2. 119. 1845, ex char.
Celastrus polybotrys Turcz. in Bull. Soc. Nat. Mosc. 31:449. 1858. (T.: *Cuming 1321*).

INDONESIA: CELEBES: Prov. Minahassa, *Koorders 19634β* (L); Makale, *Kjellberg 2907* (S); Paloe, *Curran 3415* (A). JAVA: Prov. Bawean, *Coert 3758* (L); Moenoeng, *de Voogd 682* (A, L); Poeger, Besochi, *Koorders 30178β* (L, UC); Kawi, *Mousset 1111* (L). TIMOR: Nonboumn, *Teysmann 8731* (L); Soë, *de Voogd 2338* (A, L).

PHILIPPINES: BOHOL: *Ramos s. n.*, Aug.-Oct. 1923 (A, UC). LUZON: Prov. Bataan: Lamao, *Cuiran 7499* (SING); Mt. Mariveles, *Whitford 81, 414* (F, US); Prov. Batangas, Taal Volcano, *Gates 7468* (MICH); without precise locality, *Ramos 1813* (L, MO, SING); Prov. Bulacan, *Ramos 346* (A, F, L, MO, US); Cagayan, *Cuming 1324* (L, NY, UPS); Prov. Cavite, *Ramos & Deroy s. n.*, April-May 1915 (L, US); Prov. Nueva Viscaya, *McGregor s. n.*, March-April, 1912 (MO, S); Prov. Pangasinan, *Otanes s. n.*, April-June 1914 (A, SING, US); Rizal, *Ramos 9* (US); *Ahern's collector s. n.*, March 1905 (F, SING, US); Prov. Tayabas, *Alcasid & Edaño 4669* (A); Prov. Zambales, *Fox 4864* (A); without precise locality, *Cuming 1209* (L, MO, UPS). MINDANAO: Dist. Cotabato, *Robinson s. n.*, June 1910 (F); Pagpawan Sitio, Davao Prov., *Edaño s. n.* (L); Pandarochan, *Merrill 944* (US).

1c. CELASTRUS PANICULATUS ssp. **multiflorus** (Roxb.) Ding Hou, stat. nov.

Celastrus multiflorus Roxb. Hort. Beng. 18. 1814, nom. nud.; Fl. Ind. ed. Carey & Wall. 2:389, 1824; Fl. Ind. ed. Carey 1:622. 1832, ex char., non Lamarck.
Celastrus dependens Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:389. 1824, in obs. *Celastrus multiflorus* Roxb., nom. nud.
Alsodeia glabra Burgdk. in Junghuhn, Pl. Jungh. 122. 1881–85. (T.: *Junghuhn s. n.*, L!).
Celastrus laotica Pitard, Fl. Gén. l'Indo-Chin. 1:891. 1912. (T.: *Pierre 2704*, P!).
Euonymus euphlebiphyllus Hayata, Icon. Pl. Formos. 5:15. 1915, ex char. (T.: *Fujii s.n.*).
Celastrus euphlebiphyllus (Hay.) Makino & Nemoto, Fl. Jap. ed. 2. 597. 1931.
Celastrus euphlebiphyllus (Hay.) Kanehira, Formos. Trees, ed. 2. 383, *f. 340*. 1936, nom. illegit.

BURMA: Chin Hills, *Prazer 236* (CAL); Chindwin, near Tummoc, *Prazer 167* (CAL); Kachin Hill, *Shaik Mokim s. n.*, 1897 (CAL); Koni, *Prazer s. n.*, May 1888 (CAL); Luay Wyo, *Rodger 198* (CAL); Maymyo Hill, *Badal Khan 11* (CAL); Myitkyina, *Rogers 864* (CAL); Pinmona, *Abdul Huk s. n.*, Aug. 26, 1890 (CAL); southern Shan State, Taungyi, *Abdul Khalil s. n.*, 1894 (CAL); Tavoy, Oomaigoi, *Shaik Mokim 266* (CAL, L, U); Younghue, *Carter 466* (CAL); without precise locality, *Prazer 54* (CAL), *236* (L).

CHINA: HAINAN: Ka La, *McClure 9182* (A, MO); Kan-en Hsien, *Lau 3658* (A, S); Ngai Hsien, *Lau 283* (A, MICH, MO, UC, US); Yaichow, *Liang 63042* (A), *How 70573* (A, US). TAIWAN: Kurau, Kosyun, *Ito s. n.* (photo, A). YUNNAN: Che-li, *Wang 75551, 77833, 79560* (A); Cheng-kango, Monghui, *Yu 16787* (A); Fo-Hai Hsien, *74966* (A); Jenn-yeh Hsien, *Wang 80588, 80194* (A); Shunning, *Yu 16292* (A); Szemao, *Henry 12122* (MO), *12122*^{B}, *12122*^{A} (US), *12572*^{B} (A), *11972*^{A} (US), *11993* (A, MO), *11993*^{A} (US); Ue-lung Shan (Chang-kiang Dist.), *Lau 3191* (S).

INDIA: Khasia, 1,000–3,000 ft. alt., *Hooker & Thompson s. n.* (S).

INDO-CHINA: Prov. Sonla, *4049* (A, UC); Bao-chiang, Prov. Bien-hoa, *Pierre 2794* (lectotype of *Celastrus laotica* Pitard, P); Phuoc-than, *Thorel s. n.*, 1862–66 (paratype of *C. laotica* Pitard, P); Laos, Phon-thane, *Spire 289* (paratype of *C. laotica* Pitard, P).

INDONESIA: CELEBES: Minahassa, *Lam 2466* (L). JAVA: Bantam, *Kuhl & v. Hasselt 18* (L); Madiun, Ngebel, *Koorders 29808* (L); Parve-sosa, *Backer 37252* (L); Pehalongan, *Koorders 27372B* (L); Soerabaja, *Dorgelo 2290* (L). SUMATRA: without precise locality, *Junghuhn s. n.* (type of *Alsodeia glabra* Burgdk., L).

MALAY PENINSULA: Pahang: Kwala Sunbelung, *Mat s. n.*, 1893 (SING); Sea Pardens, Perak, *Ridley s. n.*, 1892 (SING).

PHILIPPINES: Palawan, Taytay, *Merrill 9311* (A, F, L, MO, SING, US).

SIAM: Bangtapham, *Keith 213* (SING); Bitsenuloke, *Groff 6132* (UC); Kin Sayo, about 120 km. northwest of Kanburi, *Kostermans 1027* (A, L); Wangka, Nei River basin, *Kostermans 441* (L, SING); WITHOUT PRECISE LOCALITY: *Kasin 347* (L), *Sowett 752* (L).

The wide distribution and the variable leaf forms of this species have been the cause of the many synonyms. Because of the inadequacy of flowering material, I selected the middle leaf of a branch of current season's or year's growth for comparative statistical study, following Woodson's[27] method of measuring leaf characters in *Asclepias*. A study of the herbarium material according to the geographical distribution and measurable differences among the populations has demonstrated that this species includes three distinct populations, which I am treating as three subspecies (pl. 34, upper diagram).

Celastrus paniculatus ssp. *paniculatus* has leaves which are usually suborbicular or broadly obovate. It is chiefly distributed in India, but it extends to Burma, Siam, and Yunnan, China. The leaves of ssp. *multiflorus* are oblong, and its distribution is chiefly in Burma and Yunnan, where it overlaps ssp. *paniculatus*. It is also distributed in Hainan, Formosa, Siam, Indo-China, Malaya, Indonesia, and Palawan Isl., in the westernmost Philippines. The leaves of ssp. *serratus* are usually broadly ovate. This subspecies is chiefly distributed in the Philippines, and is less common in Java where it overlaps ssp. *multiflorus*.

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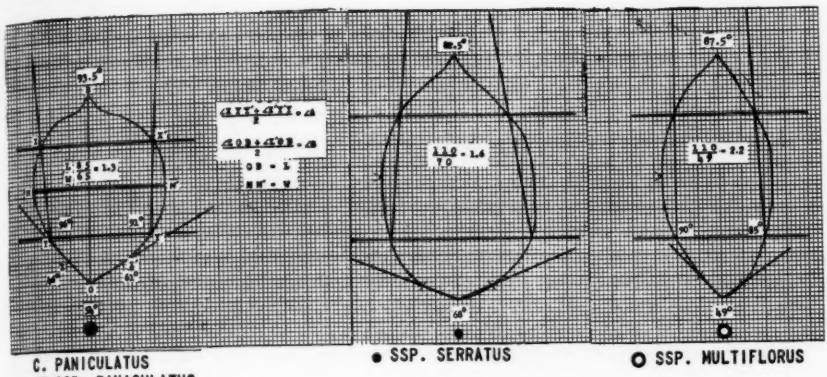
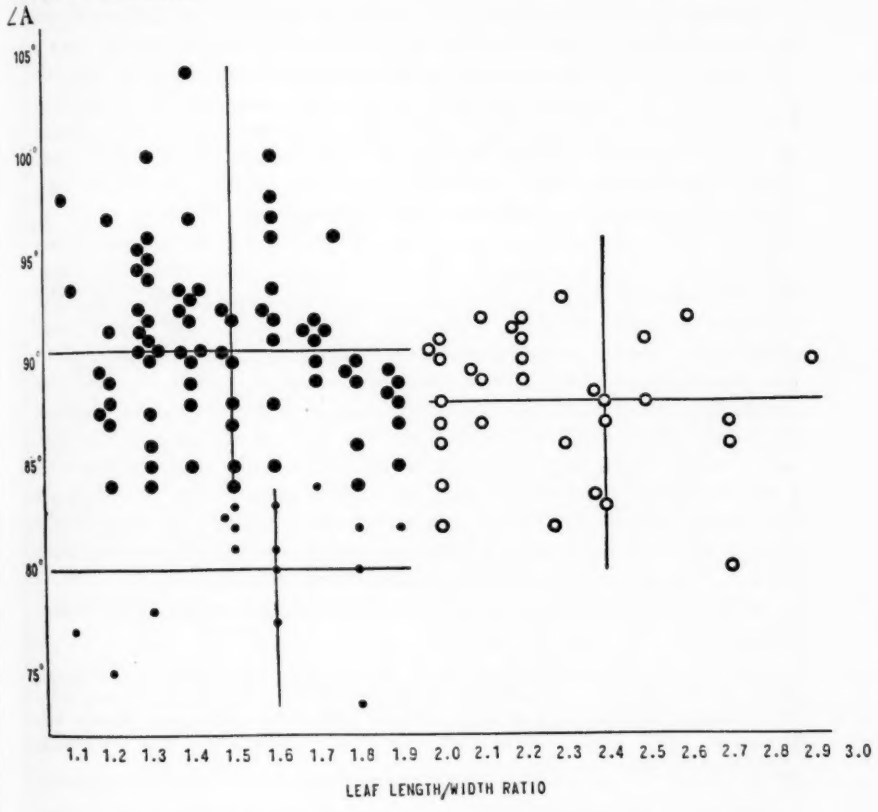
[27] Woodson, R. E., Jr. Some dynamics of leaf variation in *Asclepias tuberosa*. Ann. Mo. Bot. Gard. 34:353–432. 1947.



C. PANICULATUS
● SSP. PANICULATUS ● SSP. SERRATUS ○ SSP. MULTIFLORUS



Frequency distribution of three subspecies of *Celastrus paniculatus:* large dots, ssp. *paniculatus;* small dots, ssp. *serratus;* circles, ssp. *multiflorus.* Explanation in the text.

I have not seen any specimen of *C. paniculata* collected in Borneo, but I think that it may be found there from the distribution pattern. It is interesting to note from the geographical distribution of these three subspecies that the specimens collected in Palawan Island and Formosa belong to the ssp. *multiflorus* instead of the Philippine ssp. *serratus*. Geologically, Palawan Island and Formosa belong to the Malaysian continent.

The leaves borne on a branch of current season's or year's growth are slightly variable. If a leaf picked at random from a plant of one subspecies is compared with that of another subspecies the same size and form can be found. Following Anderson's[28] method, I have traced the leaf forms on a current season's or year's branch for each subspecies, and the differences in leaf patterns were easily observed.

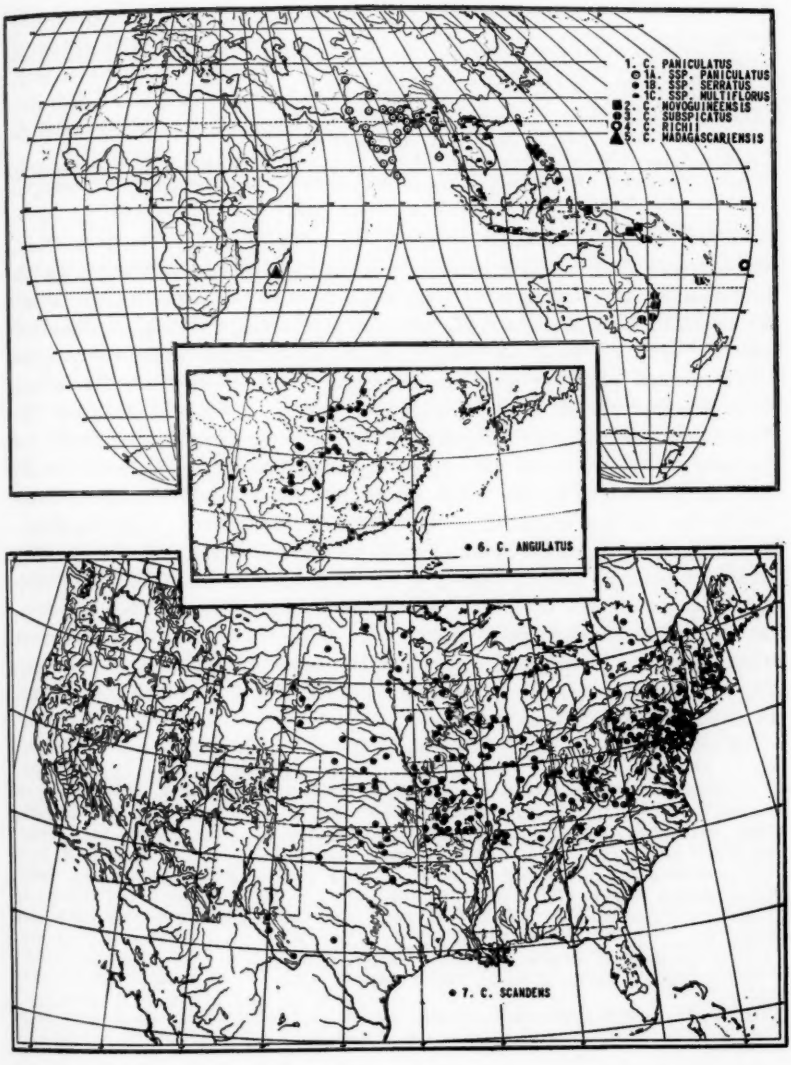
2. CELASTRUS NOVOGUINEENSIS Merr. & Perry, in Jour. Arn. Arb. 22:260. 1941. (T.: *Clemens 5152*, A!).

Scandent shrubs; branchlets terete, glabrous, brown to reddish-brown; the lenticels numerous, elliptic, elevated, white; axillary buds conoid, obtuse, about 2 mm. long. Leaves oblong, ovate to elliptic, the apex acute or obtuse, the base obtuse or rotund, the margins minutely and remotely serrulate, 12–16 cm. long, 5.0–7.5 cm. wide, firmly membranous, glabrous, the primary veins 6 pairs, elevated below, distinct, plane or slightly elevated above, the veinlets obscure below, plainly visible above; stipules linear, about 2.5 mm. long; petioles 1.0–1.5 cm. long. Inflorescences terminal, paniculiform, usually thrice compound, about 15–20 cm. long, the floriferous branchlets divaricate, the peduncles glabrous, the primary peduncles about 6–10 mm. long; flowers green, dioecious, the pedicels about 1 mm. long, the articulation varying from the lower to upper half of the stalk. Male flowers: calyx lobes imbricate, subreniform, slightly erose, about 1 mm. long; petals oblong, rotund, subentire, scarious-marginate, about 2.5 mm. long and 1.5 mm. wide, subfleshy, brownish-punctate; disc cup-shaped, membranous, the lobes obscure, truncate or mucronate; stamens subsessile or with very short flat filaments, the anthers narrow-ovoid, obtuse, apiculate, brownish-dotted; sterile pistil 1 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens 1 mm. long; pistil about 1.4 mm. long, the ovary subglobose, wider than long, the style obsolete, the stigmata 3-lobed, each bifid. Fruits subglobose, the valves broadly ovate, about 9–12 mm. long and 7–10 mm. wide, 3- to 6-seeded; seeds ellipsoid, 5–8 mm. long and 2.5–3.5 mm. wide, reddish-brown, smooth.

In thickets, at altitudes 1,220–1,830 m.; New Guinea, flowering from February to September.

NEW GUINEA: NORTHEAST NEW GUINEA: Morobe-Dist.: Oguawuang (Ogeramnang), *J. & M. S. Clemens 5152* (A, holotype), *5394* (A); Wantoat (Wantot), *Clemens 11073* (A); Yoangen (Yunzaing), *J. & M. S. Clemens 3523, 6606, 7230* (A). PAPUA: Lala River, *Carr 15698* (A). NETHERLANDS NEW GUINEA: Meervlakte, Motor bivouac, *v. Leeuwen 11098* (L).

[28] Anderson, E. Concordant versus discordant variation in relation to introgression. Evolution 5:133–141. 1951.



Map 1. Distribution of species of *Celastrus*, Subgenus CELASTRUS, Series I. PANICULATI.

This is an endemic species of New Guinea. It is distinctive and can be distinguished from other species by the thrice compound aggregate dichasia and main floriferous axis with branchlets extending out at nearly right angles. The stamens in the male flowers usually are sessile or with very short, flat filaments. The pistil in the female flower has a very short style.

3. CELASTRUS SUBSPICATUS Hook. Icon. Pl. 5:*t. 482*. 1842. (T.: *Collector unknown, s. n.*, cultivated at Kew, K!).

Celastrus australis Harv. & Muell. in Trans. Phil. Soc. Vict. 1:41. 1855; Benth. Fl. Austral. 1:398. 1863, ex char. (T.: *Mueller s. n.*).
Celastrus papuana Warb. in Engl. Bot. Jahrb. 13:366. 1891, ex char. (T.: *Warburg s.n.*).
Celastrus paniculatus Willd. var. *Balansae* Loes. in Engl. Bot. Jahrb. 39:160. 1906, ex char. (T.: *Balansa 3029*).

Scandent shrubs; branchlets terete, brownish-pubescent, the lenticels elliptic, distinct, and white; axillary buds deltoid, spiniform, about 1–2 mm. long, the outermost scales acuminate. Leaves elliptic, ovate, suborbiculate, or ovate-lanceolate, the apex acuminate, the base obtuse to acute, the margins subentire to remotely serrulate, 4–12 cm. long, 1–6 cm. wide, membranous, glabrous, the primary lateral veins 5–8 pairs, the veins and veinlets slightly elevated on both surfaces; stipules linear, about 2.5 mm. long; petioles usually 4–7 mm. long. Inflorescences terminal, once compound, rarely twice compound in the male, 2–9 cm. long, occasional in the axils of the uppermost leaves, the peduncles usually brownish-puberulous; flowers white, the pedicels about 3 mm. long, the articulation toward the base of the stalk. Male flowers (young): anthers ovoid, obtuse. Female flowers: calyx lobes imbricate, orbicular, broad, ciliate, about 1 mm. long; petals ovate-oblong, rotund, slightly erose, about 2.5 mm. long and 1.0–1.5 mm. wide; disc cup-shaped, the lobes obscure, truncate; sterile stamens 0.5 mm. long, the filaments very short; pistil ovoid, 2 mm. long, the style short, the stigmata 3-lobed, spread. Fruits subglobose, the valves broadly elliptic, about 5–10 mm. long and 5–8 mm. wide, 3- to 6-seeded; seeds ellipsoid, 5 mm. long and 2.5 mm. wide, reddish-brown, the areolae obscure.

In the thickets; Australia, New Caledonia, and Papua.

AUSTRALIA: QUEENSLAND: Cedar Beenleigh, *White s. n.*, May 1920 (SING); head of Burnett R., *Müller s. n.* (GH); Benarkin, *Cameron s. n.*, April 1924 (A); Mt. Glorious, *White 1943* (A); Ilnolan Caves, *Blakely s. n.*, June 1889 (F); Ununger, near Mt. Lindesay, *White 12517* (UC, US); Yarraman Forest Reserve, *Clemens s. n.*, Aug. 5–18, 1944 (UC); without definite locality: *Strathdickie 1124* (GH), *Clemens 43683* (A). NEW SOUTH WALES: Success Hill, *Caley s. n.*, 1807 (A, UC, US); Tweed River, *Moore s. n.* (GH); cultivated at Kew, *collector unknown s. n.* (holotype of *Celastrus subspicatus* Hook., K).
NEW CALEDONIA: *Balansa 1870* (A); *Deplanch 92* (A).
NEW GUINEA: PAPUA: Kanosia, *Carr 11260* (A, L).

Celastrus subspicatus was published by W. J. Hooker, based on a plant long cultivated in the Royal Botanic Gardens at Kew. Its history and habitat are unknown. In the type specimen, borrowed from Kew Gardens, the leaf forms, texture, short petioles, distinct and elevated lenticels, acuminate outermost

bud scales, and inflorescence patterns are similar to *Celastrus australis*. This similarity leads me to believe that *Celastrus subspicatus* of Kew Gardens was grown from seeds obtained from Australia.

Specimens collected from New Caledonia and lowland Papua, New Guinea, are morphologically similar and geographically related to the Australian ones except in the leaf shape. Meanwhile, not enough specimens are available for a population study to find out whether they really differ from the Australian species and whether they should be put into subspecific or varietal category, so they are treated tentatively as one species.

4. CELASTRUS RICHII A. Gray, in Wilkes U. S. Expl. Exped. (Bot. Phanerogam., pt. 1):289. 1854. (T.: *Wilkes Exped. s. n.*, GH!).

Scandent shrubs; branchlets terete, glabrous, light to dark brown, the lenticels distinct and numerous, white and elliptic, rarely lacking on the young branchlets; axillary buds small, conic, about 1 mm. long. Leaves elliptic, the apex and the base acute, the margins subentire or remotely serrulate, thinly membranous, shining above in dry condition, glabrous, the primary veins 5–7 pairs, elevated on both surfaces, the veinlets distinct on both surfaces, densely reticulate; stipules laciniate, filiform, about 1 mm. long; petioles 2–9 mm. long. Inflorescences terminal, once or twice compound, 2–7 cm. long, the peduncles glabrous, the primary peduncles 3.5–5.5 mm. long; flowers white, the pedicels 1.0–2.5 mm. long, accrescent, up to 15 mm. long on the fruits, the articulation toward the base of the stalk. Male flowers: calyx lobes imbricate, subreniform or semi-orbicular, about 1 mm. long, ciliate; petals oblong, entire, 3 mm. long and 2 mm. wide; disc concave, membranous, the lobes obscure, mucronate, the margins confluent with the base of the filaments; stamens about 2 mm. long, the filaments short, flat, broad at the base, gradually attenuated toward the top, glabrous, the anthers ovoid, slightly cordate and apiculate; sterile pistil conoid, 1.5 mm. long. Female flowers: calyx lobes and petals as in the male; disc cup-shaped, membranous, the lobes subreniform; sterile stamens 0.8 mm. long; pistil 2 mm. long, the ovary subglobose, the style short, the stigmata 3-lobed, each bifid. Fruits subglobose, the valves suborbicular or obovate, about 9 mm. long and 7–8 mm. wide; seeds ellipsoid, about 4.5 mm. long and 3 mm. wide, reddish-brown, distinctly areolate.

In sunny forest; at altitudes 30–900 m.; Fiji Isl.; flowering from December to May.

FIJI: FULANGA: *Smith 1122* (GH, NY, S, UC, US). VITI LEVU: Lautoka, *Greenwood 900* (A); Mba, *Smith 4301* (A, US), *5827, 6085* (A); Tholo, *Degener 14798* (NY, US), *14940, 14973* (A, NY, US), *14978* (A, MICH, NY), *15050, 15315* (A, MICH, NY, S, US); *Gillespie 4182* (GH, NY, UC); Nandi, *Degener 15330* (A, NY, S, US); Ra, *Degener 15352* (A, NY), *15424* (A, MICH, NY, S, US), *15427* (A, NY). WITHOUT PRECISE LOCALITY: *Horne 1135* (GH); *Mrs. Parham 3* (GH); *Wilkes Exped. s. n.*, 1838–42 (GH, holotype).

This is an endemic species of Fiji. Its geographical distribution and accrescent pedicels make this species easily separable from other species. A specimen collected by Degener *(15330)* in an "arid patch of forest along coast" near Nandi has obovoid fruits while all others have subgloboid ones.

5. CELASTRUS MADAGASCARIENSIS Loes. in Notiz. Bot. Gart. Berlin 13:215. 1936, ex char. (T.: *Perrier de la Bathie 2067*).

Scandent shrubs; branches terete, glabrescent, brown, the lenticels elliptic or orbicular, slightly elevated; axillary buds globose to deltoid, about 1 mm. long. Leaves usually elliptic to ovate-oblong, the apex acute to shortly acuminate, the base cuneate or obtuse, the margins crenate-serrulate, 4–7 cm. long, 2.5–3.5 cm. wide, chartaceous to firmly membranous, glabrous, the primary lateral veins 5–7 pairs, elevated on both surfaces, curved toward the apex, the veinlets distinct and slightly elevated on both surfaces; stipules laciniate, about 2 mm. long; petioles 5–11 mm. long. Inflorescences terminal, paniculiform, once compound, 1–3 cm. long, the peduncle puberulous, the primary peduncles 2–3 mm. long; flowers dioecious, the pedicels about 2.5 mm. long, the articulation toward the base of the stalk. Male flowers: calyx lobes imbricate, ovate, obtuse, slightly erose, about 1 mm. long; petals elliptic to ovate, obtuse and subentire, about 3 mm. long and 2 mm. wide; disc membranous, the lobes inconspicuous, cuspidate; stamens arising from the margin of the disc, about 3 mm. long, the filaments shorter than the anthers, glabrous, the anthers ellipsoid, distinctly apiculate; sterile pistil columnar, about 1 mm. long. Female flowers: calyx lobes, petals and disc as in the male; sterile stamens about 1 mm. long; pistil about 2.5 mm. long, the ovary globose, the style shortly columnar, the stigma discoid. Fruit unknown.

In forests; at altitudes 100–1,500 m.; endemic in Madagascar; flowering from October to November.

MADAGASCAR: Valley of the Mandraré, *d'Alleizette 1288* (L); Basaltic near Betafo, *d'Alleizette s. n.*, Sept. 1905 (L).

This species quite clearly belongs to the series PANICULATI by its distinct terminal paniculiform inflorescences. It is closely related to the Australian *Celastrus subspicatus*, rather than to the Asiatic *C. paniculatus*, by its short and once compound inflorescences. It can be distinguished from those two species by its apiculate anthers, cuspidate disc-lobes, and discoid stigma. Loesener has pointed out that the *Celastrus* species of Madagascar enumerated by Drake[29] are *Gymnosporia*. The excellent illustrations reveal that Loesener's view is quite right. Thus *Celastrus madagascariensis* is the only remaining *Celastrus* species described from Madagascar.

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[29]Drake del Castillo, M. E., in Grandidier's Hist., Phys., Nat. et Pol. Madag. 36 (Hist. Nat. Pl. Atlas 3):*pls. 280, 280a, 280b*. 1896.

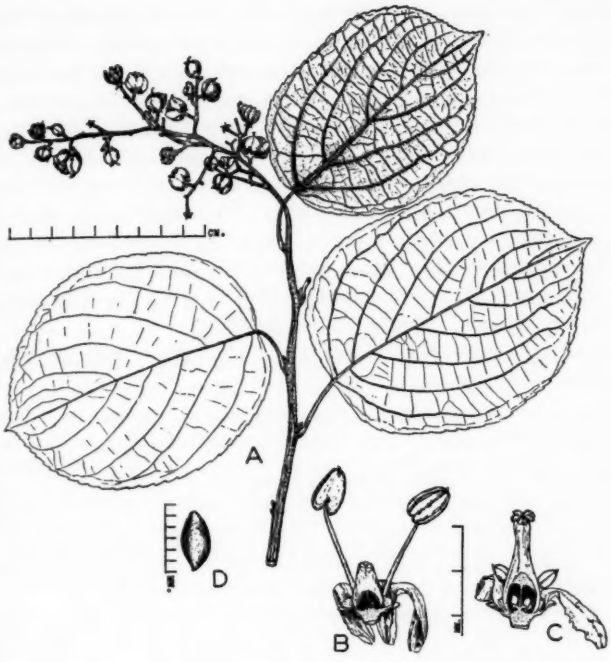


Fig. 4. *Celastrus angulatus* Maxim.

6. CELASTRUS ANGULATUS Maxim. in Bull. Acad. Sci. St. Pétersb. III, 27:455. 1881 (as *angulata*); in Mél. Biol. Acad. St. Pétersb. 11:199. 1881, ex char. (T.: *Piaseski s. n.*).

Celastrus latifolius Hemsl. in Jour. Linn. Soc. 23:123. 1886; Oliver, in Hook. Icon. Pl. *t. 2206*. 1894, ex char. & ill. (T.: *Henry s. n.*).

Scandent shrubs up to 10 m. tall; branches subterete, the branchlets usually angular, glabrous, both reddish to dark brown, shining, densely lenticellate, the lenticels small, orbicular or ovate, white; axillary buds short-ovoid, about 2–5 mm. long. Leaves broadly elliptic, broadly ovate to suborbicular, the apex abruptly acute, the base obtuse, the margins crenate-serrate, usually 9–16 cm. long, 7–15 cm. wide, firmly membranous, glabrous or pubescent on the veins below, the primary lateral veins usually 6–7 pairs, prominently elevated below, plane or slightly elevated above, the secondary lateral veins slightly elevated below, plane and visible above, nearly parallel to one another; stipules filiform, tufted; petioles 0.6–3.0 cm. long. Inflorescences terminal, densely paniculiform, up to 20 cm. long, the peduncles brownish-puberulous, the primary peduncles 5–8 mm. long; flowers small, greenish-white or yellowish-green, the pedicels obscure, the articula-

tion just beneath the flower. Male flowers: calyx lobes open, ovate or oblong-ovate, obtuse, subentire, about 1.5 mm. long; petals elliptic-oblong, obtuse, ciliate to slightly erose, reflexed, about 2.5 mm. long and 1.2 mm. wide; disc subfleshy, nearly flat, plate-like, the lobes usually depressed-subquadrate; stamens attached just under the margin of the disc, about 3 mm. long, the filaments filiform, glabrous, the anthers ovoid, obtuse, apiculate; sterile pistil ovoid, about 1 mm. long. Female flowers: calyx lobes, petals and disc as in the male; sterile stamens about 1 mm. long; pistil about 3–4 mm. long, the ovary subglobose, the style distinctly columnar, the stigmata 3-lobed, each bifid, recurved. Fruits subglobose, the valves broadly elliptic to suborbicular, about 6–9 mm. long and 5–9 mm. wide, 3- to 6-seeded; seeds ellipsoid, about 3–5 mm. long and 1.5–3.0 mm. wide, brownish-red, shining, the areolae usually obscure, rarely distinct.

In open places, light woods and thickets; at altitudes of 400–3,600 m.; China; flowering from May to June.

China: honan: Hia Hsien, *Hers 1831* (A); Hwei Hsien, *Hers 772* (A); Lushih, Hiung-eul Shan, *Hers 861* (A); Sung Hsien, *Hers 1288, 1314* (A); Teng-feng Hsien, *Hers 269* (A); Tsi-yuan Hsien, *Hers 1712* (A); Yungning, *Hers 417* (A). hupei: Chang-yang, *Wilson 753A* (A); Enshih Hsien, *Ho-ch'ang Chow 2005* (A, NY); Fang Hsien, *Wilson 364*[a], *753* (A, F, GH, MO, US); Ho-long-teng, *Silvestri 5099* (A); Ichang, *Chun & Chien 8050* (UC), *Henry 2084, 3405, 3883* (GH), *5925* (A, GH, NY), *Wilson 364* (A, F, MO, US); Ma-pan-scian, *Silvestri 1336* (A); Nanto, *Wilson 783* (A); Paokan, *Wilson 467* (A, NY); Patung Hsien, *Ho-ch'ang Chow 495, 597* (A, NY); Sin-yeh-sie, *Chun 3724* (A), *4066* (US); Tzu-kwei Hsien, *Ho-ch'ang Chow 405* (A, NY). kansu: Tienschui, *Fenzel 2817* (A). kwangsi: Ch'uan Hsien, *Tsang 27666* (US). kwangtung: Loh-ch'ang, *Tsang 20813* (A, MO, NY, SING, UC), *Tso 21152* (NY). kweichow: Kiangkou, *Steward et al 541* (A, F, NY, S, US); Kweiyang, *Tsiang 8653* (A, NY); Nganping, *Handel-Mazzetti 132* (A); Tsingchen, *Teng 90315* (A); Tsunyi, *Steward et al 97* (A, F, NY, S, US); Tuhshan, *Tsiang 699*[B] (A, NY); Tungtze, *Tsiang 4945, 4970* (A, NY). shensi: Hua-Shan, *Hers 3097* (A); Shih Tan, *Hers 2442* (A); Tai-pei Shan, *Purdom 946* (A, US), *Fenzel 738* (A); Tsi-yuan Hsien, *Hers 2670* (A); Tsinling Shan, *Fenzel 678* (A), *Hers 2932, 3010* (A); Tze-wu Hsien, *Meyer 1722* (A). szechuan: Li-fan Hsien, *Wang 21670* (A); Kwang-yun Hsien and vicinity, *Wang 22633* (A); inter Nitou et Hualinpin, *Smith 13448* (UPS); Nan-chuan, *Fang 571* (A), *1362* (A, NY); Wen-chuan, *Wilson 364*[b] (A); without precise locality, *Bock & v. Rosthorn 790* (A). yunnan: Eche-hay, *Maire 385* (A); Hsinlung, *Handel-Mazzetti 5692* (A); Tong-tch-ouan, *Maire 22, 393* (A), *6224* (UC).

This species has the largest leaves of any species of *Celastrus*. They reach as much as 16 cm. in length and 15 cm. in width. The characteristic leaves and angular branchlets with dense, small and whitish lenticels make it easily distinguishable from allied species. I saw a living plant of this species cultivated at the Brooklyn Botanic Garden, New York, which has long and dense, paniculiform fruiting branches. During winter and early spring the dehiscing fruits with their crimson arillate seeds present a beautiful and eye-catching sight. This species would make a valuable ornamental plant although it is not now used extensively.

7. Celastrus scandens L. Sp. Pl. 196. 1753; Gray, Gen. Pl. U. S. 2:186, *t. 170.* 1849, ex char.

Celastrus bullatus L. Sp. Pl. 196. 1753, ex char.
Euonymoides scandens (L.) Moench, Meth. Pl. 70. 1794.

Scandent shrubs up to 20 m. tall; branches terete, glabrous, castaneous, the lenticels scattered, orbicular or elliptic, the current year's growth yellowish-green, with lenticels lacking or inconspicuous; axillary buds subglobose, about 1.5 mm. long. Leaves elliptic, ovate-elliptic to obovate, the apex acute to short-acuminate, the base rotund to cuneate, the margins crenate-serrulate, incurved, glandular-mucronate, 4–12 cm. long, 2–6 cm. wide, membranous, glabrous; the primary lateral veins 4–6 pairs, distinct and slightly elevated on both surfaces, the veinlets visible on both surfaces; stipules filiform, tufted, about 1.5 mm. long; petioles usually 1.0–2.5 cm. long. Inflorescences terminal, usually once compound, 2–8 cm. long, the peduncles glabrous, the primary peduncles obscure to 5 mm. long; flowers dioecious, green, the pedicels obscure to 3.5 mm. long, the articulation at the upper half of the stalk. Male flowers: calyx lobes open, oblong, rotund, slightly erose, accrescent, about 1 mm. long; petals thin, more or less transparent, rotund, slightly erose, about 4 mm. long, 1.5 mm. wide; disc cup-shaped, the lobes truncate; stamens about 2.5 mm. long, the filaments slender, glabrous, the anthers ovoid, obtuse, apiculate; sterile pistil 1.2 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens about 1 mm. long; pistil flask-shaped, about 3 mm. long, the ovary ellipsoid, the style cylindric, the stigmata 3-lobed, patent. Fruiting inflorescences usually racemiform; fruits subglobose, the valves suborbicular or broadly elliptic, about 8–12 mm. long and 7–10 mm. wide; seeds ellipsoid or slightly plano-convex, obtuse at the base, attenuate toward the apex, about 4.5 mm. long and 2 mm. wide, brown, the areolae obscure.

Roadsides and thickets; lowlands up to 600 m. alt.; North America; flowering from May to June.

CANADA: ONTARIO: Algoma, Bruce, Essex, Frontenac, Glengarry, Leeds, Renfrew, Waterloo, Welland, and York counties. QUEBEC: Brome, Chambly, Chateauguay, Missisquoi, and Pontiac counties.

UNITED STATES: ARKANSAS: Benton County. CONNECTICUT: Litchfield and New Haven counties. DELAWARE: Newcastle County. ILLINOIS: Adams, Champaign, Fulton, Jackson, La Salle, Mason, Peoria, Schuyler, Stark, Vermilion, and Winnebago counties. INDIANA: Floyd, Franklin, Gibson, Jennings, Jefferson, Kosciusko, Marion, Porter, Sullivan, Tipton, and Wells counties. IOWA: Cedar, Clay, Davis, Decatur, Fayette, Hardin, Lee, Story, and Winneshiek counties. KANSAS: Cowley, Douglas, Ellis, Geary, Riley, and Wilson counties. KENTUCKY: Boyd, Fayette, Greenup, Rockcastle, and Warren counties. MAINE: Cumberland, Kennebec, Penobscot, and York counties. MARYLAND: Caroline, Cecil, Harford, Montgomery, and Talbot counties. MASSACHUSETTS: Berkshire, Dukes, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, and Suffolk counties. MICHIGAN: Cheboygan, Emmet, Keweenaw, Menominee, Midland, and Oceana counties. MINNESOTA: Clearwater, Goodhue, Hennepin, Houston, Kandiyohi, Nicollet, and Otter Tail counties. MISSOURI: Atchison, Benton, Chariton, Clay, Cole, Franklin, Hickory, Howell, Iron, Jackson, Jasper, Jefferson, Johnson, Lafayette, Lawrence, Oregon, Ozark, Polk, Ralls, Reynolds, St. Clair, St. Louis, Stoddard, Stone, Taney, Warren, and Wright counties. NEBRASKA: Antelope, Cass, Franklin, Lincoln, Sioux, Thomas, and York counties. NEW HAMPSHIRE: Cheshire, Grafton, Hillsboro, Merrimack, and Rockingham counties. NEW JERSEY: Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Gloucester, Hunterdon, Mercer, Middlesex, Monmouth, Ocean, Salem, Somerset, Sussex, and Warren counties. NEW YORK: Albany, Cayuga, Columbia, Dutchess, Orange, Saratoga, Suffolk, St. Lawrence, Tompkins, Ulster, Warren, and Washington counties. NORTH CAROLINA: Buncombe, Iredell, and Mitchell counties. NORTH DAKOTA: Pembina, Ramsey, and Stark

counties. OHIO: Clinton, Cuyahoga, Gallia, Hamilton, Harrison, Jackson, Lawrence, Meigs, Richland, Sciota, and Wood counties. OKLAHOMA: Blaine, Cleveland, Johnston, Kay, Murray, Payne, and Woodward counties. PENNSYLVANIA: Adams, Allegheny, Beaver, Bedford, Berks, Blair, Bucks, Cambria, Carbon, Center, Chester, Clarion, Clearfield, Clinton, Crawford, Cumberland, Dauphin, Delaware, Erie, Fulton, Huntingdon, Indiana, Jefferson, Juniata, Lancaster, Lebanon, Lehigh, Luzerne, Lycoming, Monroe, Montgomery, Montour, Northampton, Northumberland, Perry, Philadelphia, Pike, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Venango, Wyoming, Westmoreland, and York counties. RHODE ISLAND: Providence County. SOUTH DAKOTA: Brookings, Brule, Grant, Lawrence, and Pennington counties. TENNESSEE: Crockett, Dyer, Gibson, Hamblen, Obion, and White counties. TEXAS: Armstrong, Brewster, Culberson, Jeff Davis, and Sutton counties. VIRGINIA: Bedford, Caroline, Craig, Fauquier, Giles, Roanoke, Shenandoah, Surry, and Isle of Wight counties. VERMONT: Caledonia and Rutland counties. WEST VIRGINIA: Cabell, Marshall, Summers, and Wyoming counties. WISCONSIN: Brown, Buffalo, Door, Iowa, Kenosha, Lafayette, Outagamie, Polk, and Walworth counties. WYOMING: Crook County.

This is the only widely distributed *Celastrus* species in North America. It is also commonly cultivated as an ornamental plant in the United States. This species is easily recognized by its paniculiform inflorescences, open calyx lobes, cup-shaped disc, and especially by the crimson arillate seeds of the opening fruits. Since it is widely distributed and the only commonly known species of *Celastrus* in North America, it will not be confused in the field or in the herbarium. I have seen many specimens of this species all of which are identified correctly. In the present treatment, I have not cited individual collections, but just listed the counties where they are found. All of the collectors and their field numbers can be found in the Index to Exsiccatae at the end of this paper. The variations of morphological characters and geographical distribution of this species have been discussed under the section on general morphology.

Series 2. AXILLARES Rehd. & Wils. in Sarg. Pl. Wils. 2:355. 1915.

Sempervirentes Maxim. ex Rehd. & Wils. in Sarg. Pl. Wils. 2:357. 1915.

KEY TO THE SPECIES

A. Flowering branches terminal or rarely in some species those of the female plants intercalary.
  B. Flowering branches terminal both in male and in female plants; inflorescences both lateral and terminal.
    C. Evergreen species, the current season's branches usually subtended by foliage leaves; inflorescences usually without accompanying vegetative buds (except some specimens of *Celastrus hindsii*); fruits 1-seeded.
      D. Young branches with distinct lenticels; flowers numerous in dense umbelliform cymes; discs subfleshy or fleshy, flat; leaves not densely reticulate.
        E. Fruit conspicuously stipitate; seeds about 15 mm. long, 8 mm. wide. India, Burma, Siam, Indo-China, southwestern and southeastern China. ..... 8. *C. monospermus*
        EE. Fruit not stipitate; seeds about 9 mm. long, 5 mm. wide. Malaya, Indonesia, Philippines and New Guinea ..... 9. *C. monospermoides*
      DD. Young branches rarely with lenticels; flowers few in simple lax cymes, or solitary; discs membranous, cup-shaped; leaves densely reticulate; seeds about 6 mm. long, 5 mm. wide. Southeastern Asia ..... 10. *C. hindsii*
    CC. Deciduous species, the current season's branches not subtended by foliage leaves; inflorescences with accompanying vegetative buds; fruits 3- to 6-seeded.
      F. Flowers fasciculate or solitary, without distinct peduncles or with very short ones on the terminal inflorescences; calyx lobes imbricate; petals thin and

with distinct venation, 2.5–3.0 mm. long, 1.0–1.5 mm. wide; anthers of the male flowers 0.7–1.0 mm. long; fruiting inflorescences erect, the stalks of fruits not accrescent after anthesis, about 1.0–1.5 cm. long; seeds ellipsoid or ovoid.

G. Terminal inflorescences usually 2–6 cm. long; axillary inflorescences usually several- to many-flowered, fruiting frequently.

H. Veinlets of leaves usually immersed above and elevated beneath; seeds smooth.

I. Anthers of male flowers not apiculate; disc lobes subquadrate to oblong, obtuse or slightly emarginate; leaves usually paler beneath. Southwestern and central China and Indo-China.....11. *C. glaucophyllus*

II. Anthers of male flowers apiculate; disc lobes subreniform, mucronate; leaves concolorous. India, Burma, and China.....12. *C. hookeri*

HH. Veinlets of leaves elevated on both surfaces; seeds highly rugose. India.....13. *C. membranifolius*

GG. Terminal inflorescences usually 6–18 cm. long, axillary inflorescences few-flowered or suppressed, fruiting infrequently. Southwestern China.....14. *C. vanioti*

FF. Flowers in distinctly pedunculate dichasia on the lower two-thirds of the terminal inflorescences; calyx lobes valvate; petals relatively thicker and without distinct venation, about 4 mm. long and 2 mm. wide; anthers of the male flowers 1.5 mm. long; fruiting inflorescences pendulous, the stalks of the fruits accrescent after anthesis, about 2–4 cm. long; seeds slightly lunate. Central and western China .....15. *C. hypoleucus*

BB. Flowering branches terminal in male plants only; inflorescences both lateral and terminal in male plants, lateral only in female plants.

J. Inflorescences dichasial, conspicuously pedunculate; pedicels of fruits green.

K. Vegetative buds relatively large, ovoid, acuminate, 5–11 mm. long; leaves usually broadly ovate, rarely broadly elliptic, the secondary veinlets densely reticulate and elevated; anthers apiculate. China south of the Yangtze River .....16. *C. gemmatus*

KK. Vegetative buds relatively small, conoid, obtuse, 1–3 mm. long; leaves usually broadly elliptic, or broadly obovate to nearly orbicular, the secondary veinlets slightly reticulate and elevated; anthers not apiculate. China north of the Yangtze River, Korea, and Japan.....17. *C. orbiculatus*

JJ. Inflorescences usually fasciculate or subracemiform, usually sessile, rarely very shortly pedunculate; pedicels of fruits brown.

L. Disc lobes broader than long, about one-fourth to one-fifth as long as the disc proper, the articulation usually at the middle or lower half of the stalk. China south of the Yangtze River .....18. *C. rosthornianus*

LL. Disc lobes longer than broad, about half to one-third as long as the disc proper, the articulation usually at the upper third or upper half of the stalk. Southeastern China, Formosa, southern Japan, and Ryukyu Islands .....19. *C. punctatus*

AA. Flowering branches usually distinctly intercalary.

M. Flowers usually in pedunculate cymes, axillary or extra-axillary; leaf margins serrate, the petioles less than half as long as the blades.

N. Seeds slightly lunate, attenuate at both ends; sepals usually erose or glandular; secondary veinlets of leaves conspicuous or elevated on both surfaces.

O. Leaves usually broadly elliptic to orbicular; disc subfleshy, flat or slightly concave.

P. Plants glabrous to slightly pubescent on young flowering branchlets and the leaves beneath; leaves usually suborbicular or orbicular; disc lobes inconspicuous. China: Kwangsi, Kwangtung, Hainan, and Formosa.....20. *C. kusanoi*

PP. Plants densely yellowish brown-pubescent, especially on both surfaces of the leaves; leaves usually broadly ovate or broadly obovate; disc lobes conspicuous, arcuate. Burma, China, and Indo-China.....21. *C. hirsutus*

OO. Leaves usually elliptic or elliptic-oblong; disc membranous, cup-shaped. Eastern India, Indonesia, and China.....22. *C. stylosus*

NN. Seeds semi-annular, obtuse or rounded at both ends; sepals entire; secondary veinlets of leaves obscure on both surfaces. Southeastern China.....23. *C. aculeatus*

MM. Flowers usually solitary and axillary, or rarely fasciculate; leaf margins finely ciliate-serrate, the petioles nearly half as long as the blades. Northeastern and eastern China, Korea, and Japan .....24. *C. flagellaris*

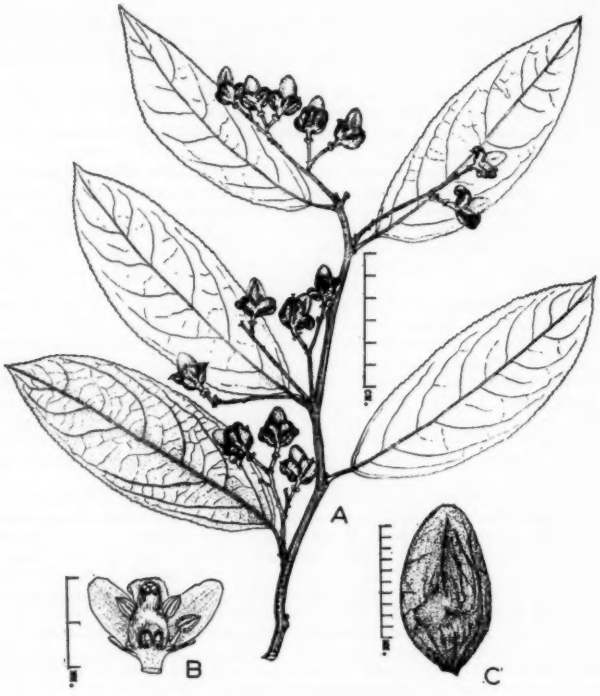


Fig. 5. *Celastrus monospermus* Roxb.

8. CELASTRUS MONOSPERMUS Roxb. Hort. Beng. 18. 1814, nom. nud.; Fl. Ind. ed. Carey & Wall. 2:394. 1824, ed. 2, 1:625. 1832 (as *monosperma*). (T.: *Desiloa s. n.* NY!).

Catha benthamii Gardn. & Champ. in Hook. Kew Jour. 1:310. 1849, ex char. (T.: *Champion s. n.*).
Celastrus championii Benth. in Hook. loc. cit. 3:334. 1851, ex char. (based on *Catha benthamii* Gardn. & Champ.).
Celastrus benthamii (Gard. & Champ.) Rehd. & Wils. in Sarg. Pl. Wils. 2:358. 1916.
Celastrus annamensis Tardieu, in Fl. Gen. l'Indo-Chine, Suppl. 1:803, *fig. 98, t. 7.* 1948, ex char. (T.: *Poilane 24300*).

Scandent shrubs up to 10 m. tall; branches terete, smooth, glabrous, reddish or dark brown, the lenticels ovate to orbicular, sparse to dense, sometimes obsolete; axillary buds conoid, about 2 mm. long. Leaves variable, elliptic to oblong or broadly ovate, the apex acute to obtuse, the base cuneate to obtuse, the margins serrate, 7–17 cm. long, 3–9 cm. wide, firmly membranous, glabrous on both surfaces, the primary lateral veins 5–8 pairs, curved toward the apex, elevated below, immersed above, the veinlets distinct, slightly elevated below, immersed and obsolete above; stipules laciniate, about 1 mm. long; petioles 0.5–1.5 cm. long. In-

florescences axillary, simply dichotomous or paniculiform, few and laxly branched, up to 20 cm. long, sometimes longer than the subtending leaf, distinctly pedunculate, the peduncles usually glabrous, rarely pubescent, the primary peduncles 0.5–3.0 cm. long; flowers dioecious, small, greenish-yellow or white, the pedicels obsolete to 4 mm. long, the articulation toward the base of the stalk. Male flowers: calyx lobes imbricate, semi-orbicular, slightly glandular-ciliate, about 1 mm. long; petals shortly oblong, about 2.5 mm. long and 2 mm. wide; disc fleshy, annular, slightly lobed, the lobes entire, subquadrate, broader than long; stamens attached just under the margin of the disc, about 2.7 mm. long, the filaments filiform, the anthers slightly ovoid, pink-punctate, slightly apiculate; sterile pistil 1.3 mm. long, ovoid, slightly immersed in the disc. Female flowers: calyx lobes, petals, and disc as in the male, usually the petals smaller than in the male; sterile stamens about 1 mm. long; pistil about 3 mm. long, the ovary subglobose, narrowed into the style, the stigmata 3-lobed, reflexed. Fruits cylindric, stipitate, 1-seeded, the valves ovate-oblong, about 2 cm. long and 1 cm. wide; seeds cylindric, about 1.5 cm. long and 0.8 cm. wide, smooth, pinkish brown.

Chiefly in thickets, at altitudes from 246 to 1,880 m.; commonly distributed in India, Pakistan, Burma, Indo-China, and China; flowering from March to June.

BURMA: Pang Hoi Phi and Peng Sai, *Rock 2237* (A, US); without precise locality, *Prazer s. n.* (CAL).

CHINA: HAINAN: Bak Sa, *Lau 26285, 26624* (A); Fan Yah, *Chun & Tso 44165* (A, F, NY), *44169* (A, NY, US); Kan-en Hsien, *Lau 3711* (A, S); Po-ting, *How 73564* (A, S); Yaichow, *How & Chun 70273* (A, NY, US), *Liang 62583* (A, NY); without precise locality, *Liang 63419* (A, L, NY, S, US), *65253* (A, NY, S, US), *Wang 35222* (NY), *35893, 36064* (A, NY), *36607* (NY). KWANGSI: Bako Shan, western Poseh, *Ching 7525* (A, UC, US); Me-kon, southern Nanning, *Ching 8433* (A, NY, UC, US); Ping Nam Hsien, *Wang 40415* (A); Shap-man-taai Shan, Shang-sze Hsien, *Tsang 22079* (A, S), *24106, 24188, 24735* (A, MO, NY); Yeo-mar Shan, northern Hin-yen, *Ching 7120* (NY). KWANGTUNG: Kowloon, *Wang 3056* (NY); Lofou Shan, *Ho 60086* (NY), *Ko 50089* (NY), *Tsiang 1705* (A, NY, UC); Lung-tau Shan, near Iu, *Kan-peng To et al 473* (UC); Sin-fung Hsien, *Taam 720* (A); Sunyi, *Ko 51463* (A); Tai-o, *Chun 3107* (NY); Tapu Hsien, *Tsang 21751* (A, NY, S); Wung-yuen Hsien, *Lau 800* (A, NY, SING), *2750* (A); Ying Tak, *Tsang & Wong 2681* (UC), *Tsui 348* (MO, NY). EASTERN TIBET & SOUTHWESTERN CHINA: without precise locality, *Forrest 26407* (A). YUNNAN: Che-li, *Wang 75920, 78458, 79015, 79459, 79776* (A); Chen Kang, *Yu 17495* (A); Fo-hai, *Wang 73579, 73590, 73825, 73839, 74430, 74907, 77202*[a] (A); Jenn-yeh Hsien, *Wang 80312, 80781* (A); Lan-tsang Hsien, *Wang 73415* (A); Lung-ling, *Tsai 55679* (A); Lu-se, *Tsai 56917* (A); Mengtze *Henry 10446* (A, NY), *10955* (A, MO), *11399* (A, MO, NY, US); between Mohei and Maokai, *Rock 2900* (A, UC, US); Nan-chiao, *Wang 75183* (A); between Palut and Nam-dip, on the trail from Raheng to Mesawt, *Rock 1024* (US); Ping-pien Hsien, *Tsai 55076, 55139, 60152, 60459, 61680, 62295* (A); Shweli-Salwin, *Forrest 11874* (UC); Si-chour Hsien, *Feng 11445, 11530, 12469* (A); Sunning, Hila, *Yu 16508* (A); Szemao, *Henry 11972* (A, NY), *11972*[B] (A, MO, NY), *Rock 2770, 2823* (A, UC, US); Tsing-pian, *Tsai 52477, 52552* (A); Tung-ting, *Feng 13472, 13749* (A); Wen-shan Hsien, *Tsai 51546, 51591, 72857* (A); without precise locality, *Wang & Ying Liu 82917, 82947* (A). HONGKONG: *Chun 40143, 40276* (NY); *Chun 4831* (UC), *4943* (A, UC); *Hom Fung 161* (NY); *Taam 1792* (A, US), *2087* (US); Lanto, *Tsiang 720* (UC); *Wright 9* (L), *92* (GH).

INDIA: ASSAM: Darrang, *Upendranath Kanjilal 3801* (CAL); Jawai, *Dr. King's collector s. n.* (L); Khasi Hills, *Kurz 182* (CAL); Kohima, *Dr. King's collector 178* (U,

UPS); Konoma, *Dr. King's collector 233* (A); Namchung, Luckimpore, *Clarke 37949*[B] (CAL); Naga Hills, *Jagarmani 499* (A, US); *Dr. King's collector 795* (A, CAL), *1082* (CAL); Silhet (as Sillet), *Desiloa s. n.* (NY, type of *Celastrus monospermus*); *Hooker & Thomson s. n.* (CAL, GH, L, S); Khasia, Liam, *Clarke 45152*[B] (CAL); without precise locality, *Griffith 666* (CAL). BENGAL: Sinchula, *Biswas 2033* (A, NY); Darjeeling, *Lace 2229* (CAL); Darjeeling, *Anderson 107* (CAL); Wangiet, *Kurz s. n.* (CAL); Runquo Valley, *Anderson 108, 109* (CAL); Sureil, *Darsteri 17* (CAL).

INDO-CHINA: Chapa, Tonkin, *Pételot 3184* (UC), *5931* (A), *6368* (A, NY, US).

PAKISTAN: *Griffith 1992* (CAL, GH, L, NY, S).

This species is distinguished readily by stipitate fruit bases, the one-seeded capsules, the large cylindric seeds, the characteristic fleshy annular disc, and the attachment of the stamens immediately beneath the margin of the disc.

The synonymy of this species is due to the failure, first, of Bentham to appreciate the true nature of Roxburgh's *Celastrus monospermus*, and later, of Gardner and Champion, of Bentham, and still later of Rehder and Wilson to appreciate the variability of that species. My present interpretation is that of Lawson (in Hook. Fl. Brit. Ind. 1:618. 1875).

Generally speaking, plants of Yunnan, Burma, and India have oblong or elliptic-oblong leaves, while those of Kwangtung and Kwangsi have broadly elliptic or broadly ovate leaves. At first I attempted either to maintain these plants as two species or to unite them into one species with two subspecies having differing leaf characters. Since then, I have measured the length and width and angles A (apical) and B (basal)[30] from the different areas, and found that the frequency curves of the ratio of length and width, and the angles A and B overlap. Since leaf shape is an extremely variable character and the floral structures of these plants are so similar, I feel justified in considering them as representing a single species.

9. CELASTRUS MONOSPERMOIDES Loes. in Lorentz, Nova Guinea 8:280. 1910. (T.: *Versteegh 1643*, L!).

Celastrus championii sensu King in Jour. Asiat. Soc. Beng. 65[2]:639. (Mat. Fl. Malay Penin. No. 8:353). 1896, as to spec. cited, non Benth.
Celastrus apoensis Elmer, Leafl. Philipp. Bot. 7:2579. 1915. (T.: *Elmer 11411*, A!).
Celastrus malayensis Ridl. in Jour. Roy. Asiat. Soc., Str. Branch 75:18. 1917. (T.: *Ridley 13538*, SING!).

Scandent shrubs up to 17 m. tall; branches terete, smooth to striate, glabrous, black or reddish-brown; lenticels lacking or obscure; axillary buds conoid, about 2 mm. long. Leaves ovate to elliptic, the apex acute to acuminate, the base shortly cuneate, obtuse to rounded, the margins serrate to nearly entire, 5–16 cm. long, 2.5–7.5 cm. wide, firmly membranous, lucid and usually blackish-brown on both sides or yellowish-green below in dry condition, the primary lateral veins 4–7 pairs, curved toward the apex, conspicuous and elevated below, plane above, the veinlets distinct and slightly elevated below, immersed and obsolete above; stipules laciniate, about 1 mm. long; petioles 6–13 mm. long. Inflorescences axillary, soli-

[30] Woodson, R. E., Jr. Some dynamics of leaf variation in *Asclepias tuberosa*. Ann. Mo. Bot. Gard. 34:353–432. 1947.

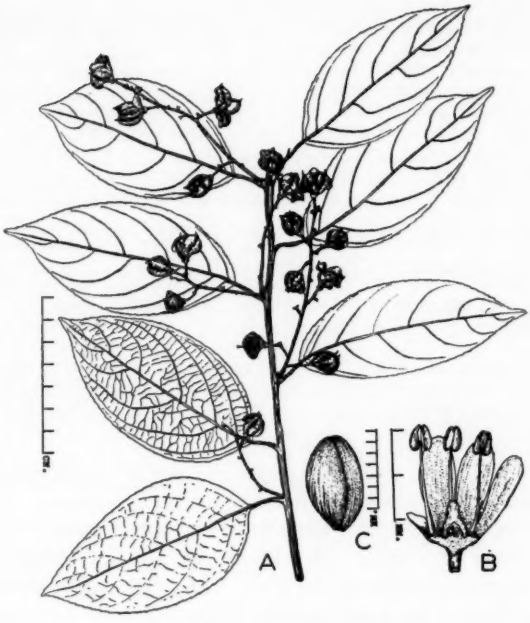


Fig. 6. *Celastrus monospermoides* Loes.

tary or in clusters of three, aggregate dichasia, frequently fasciculate-racemiform, once to thrice compound, up to 10 cm. long, the peduncles glabrous, the primary peduncles obscure to 16 mm. long; flowers dioecious, white, the pedicels about 4 mm. long, the articulation at the basal part of the stalk. Male flowers: calyx lobes imbricate, suborbicular, entire, about 0.7 mm. long; petals oblong, the apex rounded, about 2 mm. long and 1 mm. wide, entire, pink-punctate; disc fleshy, plane, the lobes obscure, truncate; stamens attached slightly under the margin of the disc, about 2.5 mm. long, the filaments filiform, glabrous, the anthers ovoid and obtuse; sterile pistil conoid, 2 mm. long. Female flowers: calyx lobes, petals, and disc as in the male, sterile stamens about 0.7 mm. long; pistil flask-shaped, 1.2 mm. long, the ovary globose, the style slender, distinct, the stigmata discoid. Fruits angular-ovoid, obovoid to subglobose, the valves ovate or obovate to broadly elliptic, about 12–17 mm. long and 7–11 mm. wide; seeds ovoid, about 7–12 mm. long and 5–10 mm. wide, blackish-brown, smooth.

In dense woods, at altitudes 100–3,300 m.; Borneo, Indonesia, Malaya, New Guinea, and Philippines; flowering from January to September.

BORNEO: western Koetai, *Endert 3846* (L). BRITISH NORTH BORNEO: Kini Taki River, *J. & M. S. Clemens 31827* (A, L), *32052* (L); Marai Parai, *J. & M. S. Clemens 32860* (L), *33182* (L, UC); Penibukan, *J. & M. S. Clemens 32120* (L), *50253* (L, UC); Upper Kinabalu, *J. & M. S. Clemens 27879, 29919* (L), *50641* (A), *51295* (A, L, UC).

SUMATRA: Gaju & Alas Land, *van Steenis 8717* (L), *9651* (A, L); old jungle near the Ack Kanopan, Loendoet concession, Koeale, *Bartlett 6864* (F, MICH, NY, US); Laboebom Batoe, Kota Pinang, *Toroes 4009* (A, NY, UC, US).

MALAYA: SELANGOR: *Ridley 8228* (SING). NEGRI SEMBILAN: Sutu, *Alims 1605, 2103* (SING). PENANG: Government Hill, *Curtis 404* (SING), *Ridley 404* (SING, paratype of *Celastrus malayensis*); Telom, *Ridley 13538* (SING, paratype of *C. malayensis*); top of Penang Hill, *Ridley 7127* (SING). PERAK: Batu Petch, *Wray 1031* (SING, paratype of *C. malayensis*); Hijan, *Haneeff & Jan 2466* (SING); Larut, *Dr. King's collector 5690* (L, SING, UC, UPS), *6928* (L, US); Maxwell's Hill, *Curtis 2005* (SING), *Ridley s. n.*, 1890 (A); Tapa, *Wray 175* (L). SINGAPORE: Sungei Loyang, *Mat s. n.*, 1894 (SING).

NEW GUINEA: DUTCH NEW GUINEA: Bali, *Stresemann s. n.*, May–Aug. 1911 (L); s. w. of Bernhard Camp, Idenburg River, *Brass 12090* (A, L); Dalman, 45 km. inward of Nabire, *Kanehira & Hatusima 12102* (A); southern New Guinea, via Resi Mts. to Hellwig Mts., *Versteegh 1643* (L, type of *Celastrus monospermoides*). NORTHEAST NEW GUINEA: Ogeramnang, Morobe, *J. & M. S. Clemens 4581, 5084, 6253* (A). PAPUA: Boridi, *Carr 13036* (A).

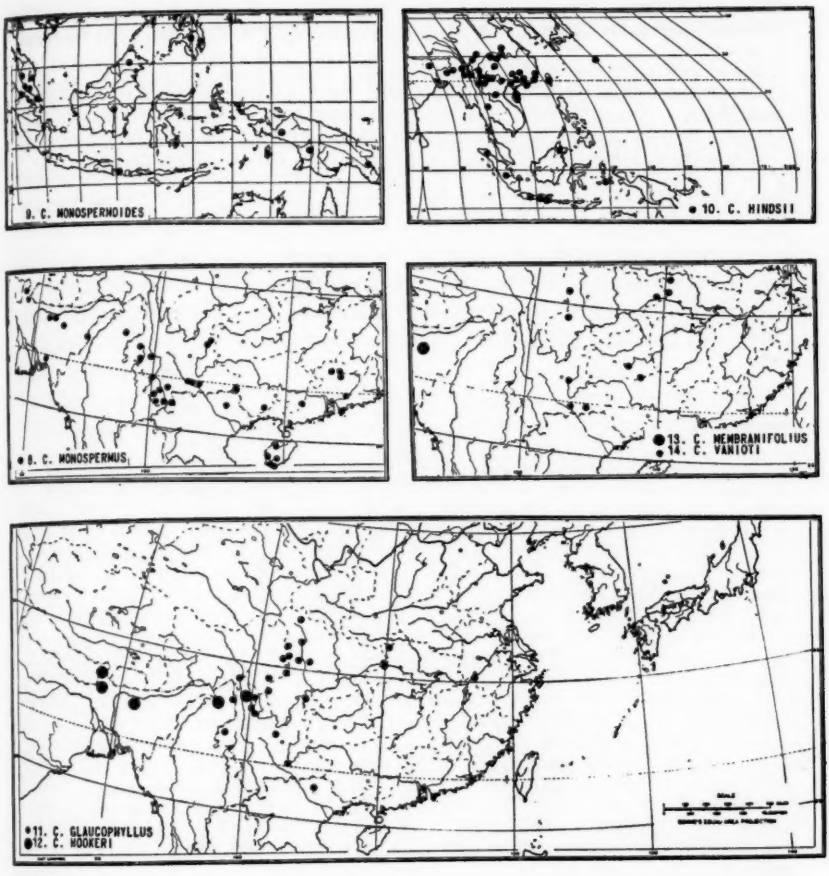
PHILIPPINES: MINDANAO: Davao, Mt. Apo, *Elmer 11411* (A, type of *Celastrus apoensis*, GH, L, MO, NY, US); Mt. McKinley, *Edaño 900* (A, L, SING, UC); Bukidnon, Mt. Dumalucpihan, *Ramos & Edaño 38961* (A, L, US); Mt. Katanglad, *Sulit 3188, 3421, 9917, 10086* (L).

The wide distribution, within geographically isolated areas, and the morphological variations of this species are the causes of several names. Specimens collected in the Malay Peninsula from lowlands up to 1,330 m. altitude have leaf forms varying from ovate to elliptic. They have thick and large leaves and long inflorescences. A specimen (*van Steenis 9651*, A, L) collected at altitude 3,000 m. from northern Sumatra has small and thin leaves and short inflorescences—about 1 cm. long.

The type specimen of *Celastrus apoensis* Elmer from Mt. Apo (alt. 2,000 m.), Mindanao, Philippines, has unusually small leaves. In addition, two other specimens (*Sulit 9917* and *10086*, L) collected at altitudes 1,700–1,800 m. from Mt. Katanglad, Mindanao, have larger leaves. The shapes and textures of leaves and inflorescences are similar to those from Malaya, Borneo, and New Guinea in similar environments.

There are several collections from Mt. Kinabalu, North Borneo, at altitude about 3,000 m. The leaf form is ovate with rounded base which is very distinctive and might be thought as a form of this species. In addition, there is a specimen (*Endert 3846*, L) collected at altitude 1,200 m. from east-central Borneo having elliptic leaves, acute at both ends. I think it may be possible, in addition to those mentioned above, to find more specimens with various leaf forms from different environments.

The leaves of the New Guinea specimens are usually elliptic, acute at both ends. They are quite similar to those from other localities in similar environments. I have made some studies and measurements of leaf characters. Except those from Mt. Kinabalu, Borneo, they can hardly be separated into groups. The shapes and sizes of fruits are variable also. As far as the shapes of fruits are concerned, those of the Malayan specimens seem to be broadly elliptic while those of the Philippine specimens are obovate. However, they display intermediate forms as well.



Map 2. Distribution of seven species of *Celastrus*, Subgenus CELASTRUS, Series II. AXILLARES.

10. CELASTRUS HINDSII Benth. in Hook. Jour. Bot. 3:334. 1851, ex char. (T.: *Hinds s. n.*).

Catha monosperma (Roxb.) Benth. in Hook. Lond. Jour. Bot. 1:483. 1842, quoad descr. & spec. cit., non sensu Roxb.
Celastrus venulosus Wall. Cat. no. 4321. 1831, nom. nud.
Celastrus racemulosus Hassk. Hort. Bogor. Descr. 1:1915. 1858, ex char.
Flueggea serrata Miq. Fl. Ind. Bat. 1:356. 1859. (T.: *Junghuhn s. n.*, L!).
Celastrus monosperma sensu Benth. Fl. Hongk. 63. 1861, non Roxb.
Celastrus cantonensis Hance, in Jour. Bot. 23:323. 1885. (T.: *Hance 22191*, A, a photo and a fragment of a leaf!).
Celastrus hindsii Benth. var. *henryi* Loes. in Engl. Bot. Jahrb. 29:444. 1901; 30:467. 1902. (T.: *Henry 3495*, A!).

Celastrus oblongifolia Hay. Icon. Pl. Formos. 3:58. 1913. (T.: *Hayata s. n.*, A!).
Celastrus marianensis Koidz. in Bot. Mag. Tokyo 30:400. 1915, ex char. (T.: Koidzumi *s. n.*).
Celastrus axillaris Ridley, in Jour. Roy. Asiat. Soc. Malay. Branch, 1:56. 1923, ex char.
Celastrus approximata Craib, in Kew Bull. Misc. Inf. 1926:349. 1926. (T.: *Kerr 9941*, SING!).
Celastrus merrillii Tardieu, in Bull. Soc. Bot. France 95:180. 1948; in Fl. Gén. l'Indo-Chine Suppl. 1:805. *fig. 98, t. 1, 2 & 3.* 1948. (T.: *Poilane 28714*, P!).

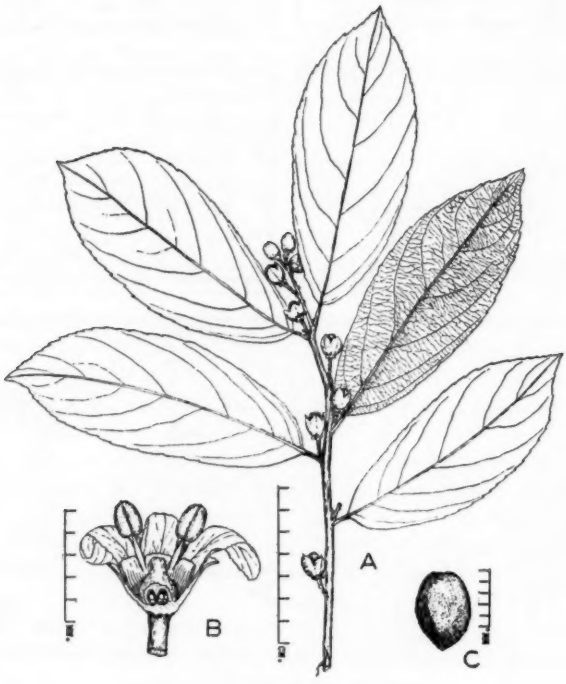


Fig. 7. *Celastrus hindsii* Benth.

Scandent shrubs up to 19 m. tall; branches terete, glabrous, brown, rarely lenticelled, the branchlets smooth and green, the lenticels usually lacking on the current season's growth; axillary buds deltoid, about 1 mm. long. Leaves elliptic-oblong, obovate-oblong, elliptic or rarely broadly elliptic, the apex abruptly acute to acute, the base cuneate to obtuse, the margins remotely and obscurely serrate to serrate, 4.0–14.5 cm. long, 1.5–6.0 cm. wide, coriaceous, shining, glabrous, the primary lateral veins 6–9 pairs, the veins and veinlets usually distinctly elevated and densely reticulated on both surfaces, rarely slightly elevated or obsolete above; stipules laciniate, about 1 mm. long; petioles about 0.5–1.0 cm. long. Inflorescences usually axillary as well as terminal, sometimes axillary only, solitary, usually 3- to 5-flowered, or sometimes racemiform and longer than the subtending leaf, the

peduncles glabrous, the primary peduncles almost obsolete to 5 mm. long, rarely up to 25 mm. long; flowers dioecious, white to pale yellow, the pedicels almost obsolete to 5 mm. long, the articulation on the upper half of the stalk. Male flowers: calyx lobes semi-orbiculate, imbricate, obtuse, ciliate, about 1.5 mm. long; petals oblong to obovate, obtuse, glandular-ciliate, 2–5 mm. long and 1.3–2.5 mm. wide; disc cup-shaped, the lobes usually deltoid, rarely slightly oblong, shortly acute, rounded, or slightly dentate; stamens arising from the margin of the disc proper, about 2.3 mm. long, the filaments subulate, glabrous, the anthers ovoid, obtuse, cordate; sterile pistil ovoid, about 1.5 mm. long. Female flowers: calyx lobes, petals, and disc as in the male, but the petals smaller; sterile stamens about 1.5 mm. long, the ovary subglobose, the style columnar, the stigmata 3-lobed. Fruits ovoid to subglobose, the valves broadly ovate to suborbicular, about 8–11 mm. long and 7–9 mm. wide, usually 1-seeded; seeds cylindric, 5–8 mm. long and 5 mm. wide, reddish-pink, smooth.

Chiefly in thickets, at altitudes from 232–1,800 m.; Bonin Islands, Burma, China, India, Indonesia, Indo-China, and Siam; flowering from January to October.

BRITISH NORTH BORNEO: Penibukan, *J. & M. S. Clemens 30493* (A, L, UC).
BURMA: Kachin Hills, *Shaik Mokim s. n.* (CAL); Kaitao, *Toppin 4292* (CAL); Kajen Lap., *Toppin 6154* (CAL).
CHINA: FUKIEN: Amoy, *Chung 335* (SING), *1771* (SING, UC), *4599, 4783, 4851, 5601* (A); Changchow, *Chung 1174, 1206* (A, UC); Chuanchow, *Chung 1084* (UC); Foochow and vicinity, *Sin Ging Tang 7039* (A), *7175* (MICH); Kuliang and vicinity, *Sin Ging Tang 6991* (MO, UC). HAINAN: Bak Sa, *Lau 26227* (A); Ching-mai Hsien, *Lei 129* (L, NY, SING, UC, US), *440* (NY, SING, UC, US); Hung-mo Shan and vicinity, Lai area, *Tsang & Fung 241* (A, US); Nodoa, *McClure s. n.* (A, MO); Yaichow, *How 70368* (A, F, NY); without precise locality, *Levine s. n.* (A, F, MO, US), *484* (A, F, GH, MO). HUPEI: Chang-lo Hsien, *Wilson 561*[A] (A); Enshih Hsien, *Ho-Ch'ang Chow 1944* (A, NY); Ichang, *Wilson 561* (A, F, GH, MO, US); Patung, *Ho-Ch'ang Chow 548* (A), *705* (A, NY), *Wilson 450* (A, NY); without precise locality, *Henry 3241* (NY, type of *Celastrus hindsii* var. *henryi*), *3495* (A, GH, US), *3856, 3495*[A] (GH), *v. Rosthorn 9* (A). KWANGTUNG: Au-tsai, *McClure 3544* (NY); Canton and vicinity, *Hance 22191* (A, photo of type of *Celastrus cantonensis*, with a piece of leaf), *Levine s. n.* (C.C.C. nos. *180*—A, UC; *441*—A, F, GH, MO, US; *1236*—A, GH, MO, US), *Merrill 10070* (UC), *Keng-ping To 1868* (UC); near Fungwang, *Kang-ping To et al 889* (US); Kochow, *Tsiang 1002* (UC), *2300* (NY); Mei Hsien, *Tsang 21422* (A); Pok-Lor, *Hom Fung A-511* (NY); Sin-fung Hsien, *Taam 587, 759* (A); Sun-wui Hsien, *Tso & Tsiang 2024* (A, F); Tai-o, *Wang 3196* (NY); Tseng-shing, *Tsang 20209* (NY); Tsung-hwa Hsien, *Tsang 20604* (MO, NY), *25019* (A); Wung-yuen, *Lau 693* (A, NY, SING), *2672* (A); Ying-tak Hsien, *Tsui 391* (A, MO, NY, UC, US), *Tsiang 1919* (SING, UC), *Tsang & Kam-chow Wong 2661* (UC); Wung-yuen, *Lau 693* (A, SING). KWEICHOW: without precise locality, *Cavalerie 3976* (A). SZECHUAN: Kiating Fu, *Wilson 3324* (A); Omei Shan, *Chiao & Fan 458, 8639, 11712, 14981, 15221* (A); *Hu 7380* (A), *Lee 4551* (A), *Wilson 2307* (A, US), *Wang 8096* (A). TAIWAN: Aderu, Heito, *Suzuki 11162* (TAI); Arisan, *Faurie 1376* (A, TAI), *Hayata s. n.* (A, photo of type of *Celastrus oblongifolius*). YUNNAN: Che-li Hsien, *Wang 75846, 79467, 79470* (A); Chen-pien Hsien, *Ko 56089* (A); Jenn-yeh Hsien, *Wang 80136, 80181, 80232* (A); Lu-se, *Tsai 56342* (A); Luh-shuen Hsien, *Wang 81177* (A); Mar-li-po, Tung-ting, *Feng 13068, 13210, 13387, 13454, 13464, 13847* (A); Mengtze, *Henry 10559* (A, MO, NY, US), *Tsai 52375* (A); Si-chour Hsien, *Feng 11685, 11862* (A); Szemao, *Henry 11972*[C] (US); Tsing-pien, *Tsai 52545* (A). HONGKONG: *Chun 4840* (A, UC); *Hance 370* (GH); *Taam 1477, 2147* (US), *1798, 1951* (A, US); *Tsang 77* (UC); *Wight 91* (GH), *611* (GH, NY).

INDIA: ASSAM: Darrang, *Upendranath Kanjilal 4976* (CAL); Kegwima, Naga Hills, *Clarke 41911*[C] (CAL); Khasia, Tserra, *Clarke 5615* (CAL). SIKKIM: Duphla Hills, *Lister 68* (CAL).

INDO-CHINA: Cho Gank, *Pételot 863* (A, UC), *991* (UC); Tonkin, *Pételot 340* (NY, US).

INDONESIA: JAVA: Thibeureum, *Arsin 19568* (L); Tjibodas, *Hallier 462* (A), *Valeton 102* (A), *Koorders 42439β* (L), *Valeton s. n.* (L, UC); Tjidadap, Tjibeber, *Winckel 92β*, *98β* (L), *1633β* (L, UC), *1682β* (L, SING); Mt. Waripin, Premyer, *Forbes 961* (CAL), GH, L); without precise locality, *Forbes 921* (CAL, GH, L), *980* (GH), *980*[a] (CAL), *Junghuhn 27, 105* (L), *s. n.* (type of *Flueggea serrata* Miq., L), *Korthals 747* (A). MOLUCCAS: Amboina, *de Vrise & Teijsmann s. n.* (L). SUMATRA: Kabajakan to Tretel, *Walter & Bangham 870* (A, NY); Waldregion, *Junghuhn s. n.* (L).

JAPAN: BONIN ISLANDS: Hah-jima, *Wilson 8300* (A).

SIAM: Kao Lem, *Kerr 9941* (SING, type of *Celastrus approximata*); Mt. Doi Chang, Chiengma, *Rock 1744* (A, UC, US).

Bentham in 1842 determined a Hongkong plant, collected by Hinds, as *Catha monosperma* (Roxb.) Benth., based on *Celastrus monosperma* Roxb. Subsequently in 1851, he described the same specimen as representing a distinct species, *Celastrus hindsii* Benth. He commented in the discussion: "The form, size, and structure of the capsule are like those of *C.* [*Celastrus*] *paniculata*, without any narrowing of the base, as in *C. monosperma* and *C. Championi*, although it is always monospermous (by abortion) as in the two latter, not three-seeded as it usually is in *C. paniculata*. All these species belong to the true *Celastri*, not to *Catha*, to which I had erroneously referred them in my former paper". So he reduced *Catha monosperma* (Roxb.) Benth. (excl. syn. Roxb.) into synonymy under *Celastrus hindsii* Benth.; but in 1861 he again adopted *Celastrus monospermus* Roxb. for the Hongkong plant and reduced his own *Celastrus hindsii* to synonymy. Actually, *Celastrus hindsii* Benth. is readily distinguished from *Celastrus monospermus* Roxb. in both vegetative and reproductive structures, as Bentham has pointed out in the discussion under *Celastrus hindsii*, and the two species should be maintained as distinct.

The firmly membranous leaves usually are elliptic-oblong, shining, and densely reticulate; and the capsules usually one-seeded, which make this species very easily distinguished from the others.

I have seen a photograph of the type specimen and fragment of a leaf from the type of *Celastrus cantonensis* Hance. This plant has leaves, venation, and inflorescences which match the description of *Celastrus hindsii*.

The original description indicates that *Celastrus hindsii* var. *henryi* Loes. differs only from the typical variety by the larger and thicker leaves, and also the nearly immersed obsolete veins. Later (1916) Rehder and Wilson stated: "in addition to the characters given by Loesener the variety differs from the type species in having subsessile and very shortly peduncled cymes". In all the specimens seen, I have not been able to distinguish with certainty var. *henryi* from the typical variety. Also, this variety does not differ at all from the typical form of the species in geographical range. Thus, this variety is reduced to synonymy here.

A specimen collected from Yunnan by Wang (no. *76880*) has leaves like *Celastrus hindsii* whereas the fruits are similar to *C. monospermus*. This may be a hybrid between the two, if indeed they are distinct.

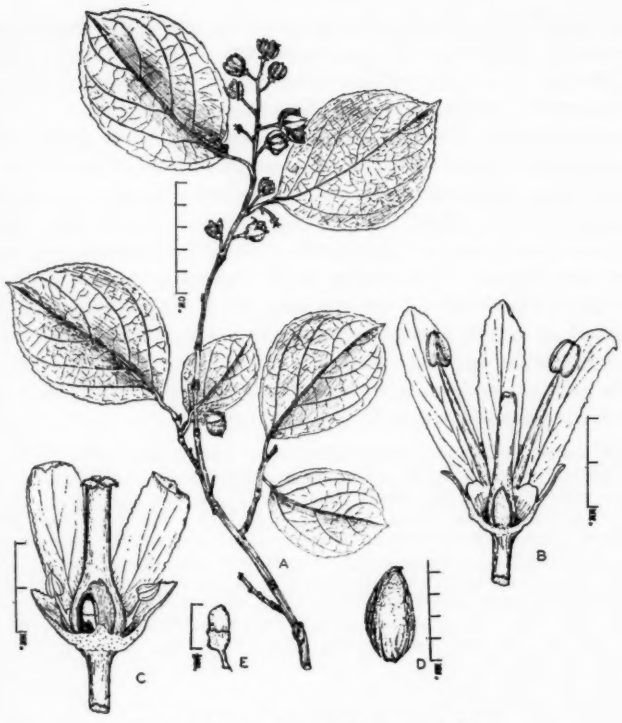


Fig. 8. *Celastrus glaucophyllus* Rehd. & Wils.

11. CELASTRUS GLAUCOPHYLLUS Rehd. & Wils. in Sarg. Pl. Wils. 2:347. 1915. (T.: *Wilson 952*, A!).

Celastrus rugosus Rehd. & Wils. loc. cit. 2:349. 1915. (T.: *Wilson 1106*, A!).
Celastrus orbiculatus sensu Tardieu, in Fl. Gén. l'Indo-Chine, Suppl. 1:806. 1948, non Thunb., as to spec. cited.

Scandent shrubs up to 2–5 m. tall; branches terete, glabrous, castaneous, the lenticels scattered, elliptic; branchlets glabrous, yellowish-brown, the lenticels lacking or obscure, rarely distinct; axillary buds ovoid, obtuse, about 3 mm. long. Leaves elliptic, obovate or ovate, the apex acute to shortly acuminate, the base rotund to broadly cuneate, the margins crenate-serrate, 4–13 cm. long, 2.5–8.0 cm. wide, firmly membranous, glabrous, or pubescent on the veins below, rarely bullate, usually glaucous or pale beneath, the primary lateral veins 5–7 pairs, elevated below, immersed to slightly elevated above, the veinlets distinct, slightly elevated below, immersed and obscure above; stipules laciniate, filiform, about 1.5 mm. long; petioles 5–15 mm. long. Inflorescences axillary as well as terminal, the axillary inflorescences 3- to 7-flowered, the terminal ones racemiform, usually 2–6

cm. long, the peduncles suppressed or up to 2 mm. long, glabrous, each associated with an axillary bud except the uppermost one of the terminal inflorescences; flowers dioecious, green, the pedicels about 2 mm. long, the articulation at the middle or upper half of the stalk. Male flowers: calyx lobes valvate, ovate, rotund, glandular-ciliate, about 1.5 mm. long; petals oblong, rotund, slightly erose, 3–4 mm. long and 1.0–1.5 mm. wide; disc membranous, the lobes ovate, obtuse; stamens 2.5–4.5 mm. long, the filaments filiform, the anthers ellipsoid; sterile pistil 1 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; pistil flask-shaped, 5 mm. long, the ovary globose, the style distinct, slender, the stigmata 3-lobed, the lobes patent. Fruits subglobose, the pedicels accrescent, about 3–5 mm. long, the valves suborbicular, 7–10 mm. long and 8–9 mm. wide, 3- to 6-seeded. Seeds ellipsoid to slightly plano-convex, about 3–4 mm. long and 2 mm. wide, black, the areolae distinct.

Chiefly in mixed thickets, at altitudes from 700 to 3,300 m.; China and Indo-China; flowering from March to June.

China: anhwei: Chu-hwa Shan, *Ching 2700* (UC), *Sun 1189* (NY). hupei: Chienshih Hsien, *Chow 1436* (A); Fang Hsien, *Wilson 357* (A, MO, US), *972* (A). sikang: Kangting (Tachien-lu), *Smith 13326* (UPS), *Wilson 4117, 4122* (A); I-tung, *Chiao 1721* (A); Tien-chuan Hsien, *Tai et al 5142* (A). szechuan: Han-yuan Hsien, *Fang 3737* (A); inter Hohsi et Telipu, *Schneider 1131* (A); Juei-she Hsien, *Yu 941, 951* (A); west of Kuan Hsien, *Wilson 4317* (A); Mo-tien-ling, *Wang 22462* (A); Mupin, *Wilson 952* (A, holotype of *C. glaucophyllus;* GH, MO, US), *1148, 2310* (A, US), *3325* (A); Ning-yuan-fu, *Schneider 1027* (GH); Omei Shan, *Chiao & Fan 767* (A), *Chow 6448, 6468, 7597, 8028* (A), *Fang 3089* (A, NY), *12883, 13051* (A, US), *16624, 17317* (A), *Hu 7380* (A), *Lee 3561* (A), *Tai 204, 1071* (A), *Wilson 4782* (A); O-pien Hsien, *Yu-shih Liu 2231* (A), *Yu 750* (A); Ping-shan Hsien, *Wang 22643* (A); Sungpan Hsien, *Wilson 4157* (A), *Fang 4176* (A); Tu-yung-pu, *Schneider 4130* (A); Wa-shan, *Wilson 952*[A] (A), *1106* (A, type of *Celastrus rugosus;* MO); west of Wen-chuan, *Wang 21124* (A); Yen-yuan Hsien, *Schneider 4112* (A); Wa-shan, *Wilson 952*[A] (A); without precise locality, *Fang 1202* (A, NY), *Schneider 646, 647* (A). yunnan: Che-tse-lo, *Tsai 58555* (A); Chien-chuan-Mekong Divide, *Forrest 22235, 22475, 23230* (A, US); Chung-tien, *Feng 3299* (A); western flank of Haba Snow Range, *Feng 1226* (A); Hokin, *Feng 787* (A); Kumming, *Wang 62839* (A); Lan-ping Hsien, *Tsai 54026* (A); Mengtze, *Henry 9679* (NY, US); Pe-yen-tsin, *Ten 40* (A), *550* (A, US); Ping-pien Hsien, *Tsai 61004* (A); south of Red River, Manmei, *Henry 9679*[A] (A, MO, NY); Ta-pin-tze, *Ten 358* (A, US); Tengchuan, *Schneider 2874* (A, GH, US); Likiang, *Ching 20489, 20638, 21618* (A), *Feng 3047* (A), *Rock 3556* (A, UC, US), *3931* (A, US), *4032* (A, UC, US), *8312* (A), *8540* (A, NY, UC, US), *Schneider 1984, 2839* (A, GH); Wei-se Hsien, *Tsai 57899, 59824* (A).

Indo-China: Chapa, Tonkin, *Pételot 5941* (A, NY).

12. Celastrus hookeri Prain, in Jour. Asiat. Soc. Bengal 73:179. 1904; Novic. Ind. 418. 1905. (T.: *Hooker s. n.*, CAL!).

Celastrus stylosa sensu Lawson, in Hook. Pl. Brit. Ind. 1:618. 1875 (pro parte, non Wall.). *Celastrus stylosa* Wall. var. *Loeseneri* (Rehd. & Wils.) Tardieu, in Fl. Gén. l'Indo-Chine, Suppl. 1:806. 1948, sensu Tardieu, non Rehd. & Wils.

Scandent shrubs up to 10 m. tall; branches terete to slightly striate, glabrous, brown to reddish-brown, the lenticels sparse or lacking on the current year's growth, suborbiculate to elliptic; axillary buds conoid, 2–4 mm. long, the bud

scales accrescent, persistent. Leaves broadly elliptic to ovate, the apex acute, the base obtuse, the margins serrate, 6–12 cm. long, 4–7 cm. wide, thin-membranous on flowering branches, glabrous, the primary lateral veins 5–6 pairs, slightly elevated below, immersed and distinct above, the veinlets visible below, obscure above, relatively thick-membranous on fruiting branches; stipules laciniate, about 1.5 mm. long; petioles 8–15 mm. long. Inflorescences axillary as well as terminal, the axillary ones 3- to 5-flowered, the primary peduncles glabrous, about 1.5–3.5 mm. long, the terminal inflorescences very short-pedunculate dichasia, fasciculate or solitary, about 4 cm. long, the axils of the peduncles associated with vegetative buds (except the uppermost); flowers dioecious, green, the pedicels 1.5–2.4 mm. long, the articulation on the upper half of the stalk. Male flowers: calyx lobes deltoid, imbricate, ciliate, about 1.5 mm. long; petals oblong to obovate, slightly glandular on the margins, about 3.5 mm. long and 1.5 mm. wide; disc cup-shaped, the lobes subreniform; stamens arising from the margin of the disc proper, about 2 mm. long, the filaments linear, glabrous, the anthers apiculate; sterile pistil 1.5 mm. long. Female flowers: calyx lobes, petals, and disc as in the male, the sterile stamens 1.5 mm. long, the pistil 4 mm. long, the ovary globose, narrowed into a distinct style, the stigmata 3-lobed, each lobe bifid, linear. Fruits subglobose, the valves broadly elliptic, about 10 mm. long and 7 mm. wide, 3- to 6-seeded; seeds ellipsoid or ovoid, about 4 mm. long and 2 mm. wide, black, the areolae distinct.

Chiefly in thickets, at altitudes from 1,525 to 3,050 m.; Burma, India, China, and Pakistan; flowering from March to May.

BURMA: Adung Valley, *Kingdon Ward 9455* (A); Bhamo, Lapyeka to Sinlum Kaba, *Lace 5775* (CAL); without precise locality, *Prazer s. n.*, 1890 (CAL), *Lace 5753* (CAL).
CHINA: YUNNAN: between Chienchuan Plain and the Mekong drainage basin to Lachining, *Rock 8615* (A, UC, US); Wei-se Hsien, *Tsai 59901* (A); without precise locality, *Yu 8491* (A).
INDIA: ASSAM: Khasia, *Griffith 605* (CAL). BENGAL: Darjeeling, *Clarke 682*[C], *27040*[D], *35758*[E] (CAL), *Gamble 1926*[A] (CAL); Jalubaham, *King s. n.*, May 9, 1876 (CAL). SIKKIM: Lachung, *Gammie 1179* (CAL); Lachen, *Dr. King's collector s. n.*, May 1885 (CAL); Lebong, *Kurz s. n.* (CAL); Pauree, *Dr. Prain's collector 289* (CAL); Lachen, *Clarke 46569* (CAL). WITHOUT PRECISE LOCALITY: temp. region, 8,000–10,000 ft., *Hooker s. n.* (type of *Celastrus hookeri*, CAL), *Kurz s. n.* (CAL).
PAKISTAN: *Griffith 1993* (CAL, GH).

Rehder and Wilson [31] have cited two Indian specimens, *Hooker & Thomson*, "Khasia, alt. 4–5,000 ped." and *C. G. Rogers*, "Sikkim, January 1900", as *Celastrus hookeri* Prain. Actually, they are *Celastrus stylosus* Wall. As it was stated by Prain, "The two can be at once distinguished by the stamens which have hirsute filaments in *Celastrus stylosus*, but glabrous ones in Hooker's species". In addition, the intercalary inflorescences and slightly lunate seeds of *Celastrus stylosus* are easily distinguished from terminal inflorescences and ovoid seeds of *C. hookeri*.

13. CELASTRUS MEMBRANIFOLIUS Prain, in Jour. Asiat. Soc. Bengal 73:197. 1904; Novic. Ind. 418. 1905. (T.: *Mann s. n.*, CAL!).

Branches terete, the branchlets slightly angular on the dry specimens, glabrous,

[31] Rehder, A., and Wilson, E. H., in Sarg. Pl. Wils. 2:352. 1915.

the lenticels scattered, ovate or orbiculate; axillary buds conoid, acute, about 1.5 mm. long. Leaves ovate-lanceolate to elliptic, the apex acuminate, the base cuneate, the margins serrate, 7.5–14.0 cm. long, 3.5–5.5 cm. wide, membranous, pale green in dry condition, glabrous, the primary veins 4–5 pairs, elevated below, immersed or slightly elevated above, the veinlets prominent on both surfaces; petioles 1.0–1.5 cm. long. Flowers unseen. Fruiting inflorescences axillary as well as terminal, short-pedunculate or fasciculate, associated with axillary buds, the stalks 7–15 mm. long, the articulation on the upper half of the stalk. Fruits subglobose, the valves broadly elliptic, about 7 mm. long and 5 mm. wide, 3- to 6-seeded; seeds elliptic, rotund at both ends, wrinkled (immature?), black, about 2–3 mm. long and 1–2 mm. wide.

INDIA: ASSAM: Khasia and Junteah Hills, *Mann s. n.*, 1877 (CAL, type; MO); Khasia Hills and Brahmaputra plains, *Kurz s. n.* (CAL).

The few specimens available are fruiting specimens in which the seeds are highly wrinkled, indicating that they might be immature. However, I have seen no immature seeds with such wrinkling in any other species of *Celastrus*.

14. CELASTRUS VANIOTI (Lévl.) Rehd. in Jour. Arn. Arb. 14:249. 1933.

Saurauja vaniota Lévl. Fl. Kouy-Tchéou, 415. 1915. (T.: *Bodinier s. n.*, A!).
Celastrus spiciformis Rehd. & Wils. in Sarg. Pl. Wils. 2:348. 1915. (T.: *Wilson 2312*, A!).
Celastrus spiciformis var. *laevis* loc. cit. 2:349. 1915. (T.: *Wilson 1176*, A!).

Scandent shrubs up to 10 m. tall; branches terete or slightly striate, glabrous, light brown to reddish or fuscous, the lenticels scattered, orbicular or elliptic, sometimes lacking on the current year's growth, slightly elevated on the older branches; axillary buds globose, about 2 mm. long. Leaves ovate or elliptic, the apex acute to shortly acuminate, the base rotund to shortly cuneate, the margins crenate-serrate, the teeth incurved, glandular-mucronate, 5–13 cm. long, 3.5–7.5 cm. wide, membranous, glabrous or slightly puberulous on the veins below, the primary lateral veins 6–7 pairs, slightly elevated on both surfaces, the secondary lateral veins parallel; stipules laciniate, filiform, about 1.5 mm. long; petioles 1–2 cm. long. Inflorescences axillary as well as terminal, shortly pedunculate or fasciculate, the peduncles almost obsolete to 5 mm. long, the axillary inflorescences dichasia or very short-racemiform, sometimes lacking in the axils on the current season's growth, the terminal inflorescences fasciculate-racemiform, 6–18 cm. long, associated with axillary buds; flowers dioecious, greenish-white, the pedicels about 2 mm. long, the articulation at the middle or on the lower half of the stalk. Male flowers: calyx lobes deltoid, imbricate, obtuse, glandular-ciliate, about 1 mm. long; petals oblong, rotund, slightly erose, about 3 mm. long and 1.5 mm. wide; disc cup-shaped, membranous, the lobes acute; stamens arising from the margin of the disc proper, about 2.5 mm. long, the filaments linear, glabrous, the anthers ovoid, obtuse, slightly apiculate; sterile pistil conic, about 1 mm. long. Female flowers: calyx

lobes, petals, and disc as in the male; sterile stamens 1 mm. long; pistil 3 mm. long, the ovary ellipsoid, gradually attenuate into the style, the stigmata 3-lobed and spreading. Fruits subglobose, the valves broadly ovate, about 9 mm. long and 8 mm. wide, 3- to 6-seeded; seeds ellipsoid, obtuse at both ends, areolae distinct, about 4 mm. long and 2 mm. wide, black.

In mixed woods, at altitudes from 500 to 2,000 m.; China; flowering from May to July.

CHINA: HUNAN: Wukang, *Te-hui Wang 113* (A). HUPEI: Fang Hsien, *Wilson 2215* (A, NY); Heing-shan Hsien, *Wilson 2312* (A, type of *Celastrus spiciformis;* GH, MO); without precise locality, *Henry 5935* (A, GH, US), *Wilson 2215*[a] (NY). KWEICHOW: Bin Long, Miu Shan, Luchen, *Ching 6057* (NY); Tuhshan, *Tsiang 6655, 6993* (NY); without precise locality, *Bodinier 2287* (A, type of *Sauravia vanioti*). SZECHUAN: Loo-shan Hsien, *Wang 23582* (A); Ma-pien Hsien, *Wang 23101* (A); Omei Shan, *Chow 7094* (A), *Fang 18958* (A), *Sun & Chang 140, 286* (A), *Wang 8035* (A, US); Wa-shan, *Wilson 1176* (A, holotype of *Celastrus spiciformis* var. *laevis*), *1383* (A, NY). YUNNAN: Mengtze, *Henry 11006* (A, MO, NY); Tong Tch'ouan, *Maire 6227* (UC); Wen-shan Hsien, *Feng 11165* (A); Yi-liang Hsien, *Tsai 52090* (A).

Celastrus vanioti, as pointed out by Rehder and Wilson, "is a puzzling plant somewhat intermediate in character between *C. angulata* Maximowicz and *C. hypoleuca* Warburg". It appears to be a hybrid between those two species. Superficially, the type of *C. spiciformis* is similar to *C. angulatus*, except for the inflorescences which are both terminal and axillary. On examination, the floral structures were found to be similar to those of *Celastrus hypoleucus*.

15. CELASTRUS HYPOLEUCUS (Oliv.) Warb. apud Loes. in Engl. Bot. Jahrb. 29:445. 1900 (as *hypoleuca*).

Erythrospermum hypoleucum Oliv. in Hook. Icon. III, 9:*t. 1899*. 1889, ex char. & ill. (T.: *Henry 5877*).
Celastrus hypoglaucus Hemsl. in Ann. Bot. 9:150. 1895. (T.: *Henry 2837*, GH!).
Celastrus hypoleucus forma α *genuina* Loes. in Diels, in Engl. Bot. Jahrb. 29:445. 1900 (based on *Erythrospermum hypoleucum* Oliv.).
Celastrus hypoleucus forma β *argutior* Loes. loc. cit. 1900. (T.: *Henry 6771*, A!).

Scandent shrubs 3–5 m. tall; branches slightly striate, glabrous, darkish brown, the lenticels sparse to dense, rarely lacking on the current year's growth; axillary buds orbicular, about 2 mm. in diameter. Leaves elliptic to elliptic-oblong, the apex acute, the base obtuse, the margins remotely serrate to serrulate, 3.0–9.5 cm. long, 2.0–5.5 cm. wide, usually delicately membranaceous, glabrous, sometimes puberulous on the veins below, glaucous below, pallid above, the primary lateral veins 5–6 pairs, slightly elevated below, immersed above, the veinlets prominent below, obscure above; stipules filiform, about 2 mm. long; petioles 1–2 cm. long. Inflorescences axillary as well as terminal, the terminal portion usually up to 10 cm. long, usually short-pedunculate, the peduncles glabrous, accrescent, the primary peduncles usually 2–8 mm. long; flowers dioecious, light green or yellow, the pedicels accrescent, about 2–8 mm. long, the articulation at the upper half of the stalk, after anthesis usually only the flowers of the terminal inflorescences maturing into fruits, and the stalk accrescent up to 4 cm. long, spreading and

pendulous. Male flowers: calyx lobes valvate, deltoid to oblong, subentire to slightly erose, about 1.5 mm. long; petals oblong or rarely elliptic, usually entire, rarely obscurely erose, about 4.3 mm. long and 2 mm. wide; disc cup-shaped, the lobes obscure, truncate to mucronate; stamens arising from the margin of the disc proper, about 4 mm. long, the filaments filiform, glabrous, about 3 mm. long, the anthers ovoid, slightly apiculate, about 1.5 mm. long; sterile pistil about 2 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens about 1.5 mm. long; pistil flask-shaped, about 3 mm. long, the ovary ellipsoid, the style cylindric, distinct, the stigmata 3-lobed, flat, spreading. Fruits subglobose, the valves broadly elliptic or suborbicular, about 8–12 mm. long and 8–10 mm. wide, irregularly pink-punctate within, 3- to 6-seeded; seeds more or less plano-convex to slightly lunate, attenuate at both ends, about 6 mm. long and 2 mm. wide, black-brown, the areolae distinct.

Chiefly in thickets, at altitudes from 1,700 to 2,745 m.; China; flowering from June to July.

CHINA: ANHWEI: Wang Shan, *Ching 3065* (UC). HUPEI: Fang Hsien, *Wilson 362* (A, F, GH, MO, US); Hsun-tien-tsze, *Chun 4427* (A); Ichang, *Wilson 1063* (A, NY); without precise locality, *Henry 2837* (GH, paratype of *Celastrus hypoglaucus*), *5887* (GH, NY, US), *6811* (GH), *6771* (A, type of *Celastrus hypoleucus* forma β *argutior*; US). SHENSI: Kin-qua Shan, *Giraldi s. n.*, July 10, 1897 (A); Qua-in Shan, *Giraldi s. n.*, July 16, 1897 (A); Tai-pei Shan, *Giraldi s. n.*, July 15–20, 1897 (A); Tsinling, *Fenzel 927* (A). SZECHUAN: Kuan Hsien, *Wilson 2306* (A, US).

This species is easily recognized by its long terminal pendulous racemiform dichasia of long accrescent stalked fruits and by the slightly lunate seeds. The leaves are usually glaucous below, but this character is extremely variable.

16. CELASTRUS GEMMATUS Loes. in Engl. Bot. Jahrb. 30:468. 1901 (as *gemmata*). (T.: *Henry 9872*[A], MO!).

Embelia esquirolii Lévl. in Fedde, Rep. Sp. Nov. 10:374. 1912. (T.: *Esquirol 4*, A!).
Celastrus lokchongensis Masamune, in Trans. Nat. Hist. Soc. Formosa 25:15. 1935. (T.: *Tsiang 1346*, A!).

Scandent shrubs, 3–7 m. tall; branches terete or slightly striate, light to darkish brown, the lenticels scattered, suborbicular or oval, usually elevated, white; axillary buds conoid, acuminate, about 4–11 mm. long. Leaves usually broadly elliptic to elliptic-ovate, the apex gradually acuminate to acute, the base obtuse, rotund or truncate, the margins serrate, 5–15 cm. long, 2–8 cm. wide, firmly membranous, usually glabrous, rarely yellowish-puberulous on the veins below, the primary lateral veins 5–7 pairs, curved toward the apex, the veinlets densely reticulate, the veins and veinlets elevated on both surfaces; stipules filiform, tufted, about 1.5 mm. long; petioles 1.0–2.5 cm. long. Inflorescences axillary, usually 3- to 7-flowered, the peduncles glabrous, the primary peduncles 4–7 mm. long; flowers dioecious, white or yellowish-green, the pedicels 3–8 mm. long, the articulation at the lower half of the stalk. Male flowers: calyx lobes valvate, ovate-deltoid, obtuse, glandular-ciliate, about 1 mm. long; petals subequal, obtuse,

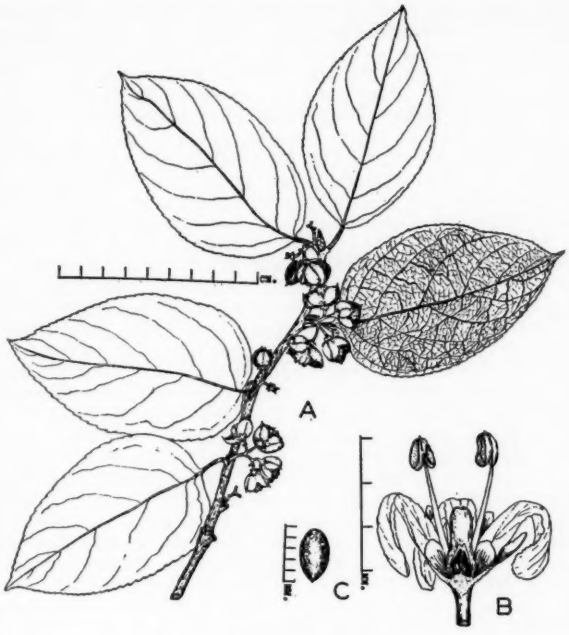


Fig. 9. *Celastrus gemmatus* Loes.

slightly erose, about 3.5–4.5 mm. long and 1.5–2.0 mm. wide; stamens inserted between the disc lobes, about 3 mm. long, the filaments more or less complanate, glabrous, gradually tapered toward the apex, the anthers oblong-ellipsoid, obtuse, usually apiculate, pink-punctate; disc thin, cup-shaped, the lobes acute; sterile pistil columnar, 1.5–2.5 mm. long. Female flowers: calyx lobes and petals as in the male; sterile stamens about 1 mm. long; disc thin, cup-shaped, the lobes inconspicuous; pistil flask-shaped, about 4 mm. long, the ovary ovoid, the style columnar, the stigmata 3-lobed, each bifid, reflexed. Fruits usually 1–3 on each dichasium, the pedicels green, the fruits subglobose, the valves broadly oval or suborbicular, 7–15 mm. long and 7–15 mm. wide, 3- to 6-seeded; seeds ellipsoid or ovoid, about 4.5 mm. long and 2.5 mm. wide, reddish-brown, smooth.

Common in thickets, valleys or open slopes, at altitudes from 400 to 3,000 m.; widely distributed in China: south of the Yangtze River; flowering from April to October.

CHINA: ANHWEI: Chu-hwa Shan, *Ching 2638* (A, UC), *7566* (UC); Wang Shan, *Ling 1159, 1246* (UC); Wu-yuen, *Ling 1349* (UC). CHEKIANG: east Tien-mu, *Hu 1585* (A, UC). FUKIEN: Dingschou, Tienhwa-schan, *Wang 399* (A). HUPEI: Fang Hsien, *Wilson 919* (A, NY), *2215*[a] (A); Sin-shan Hsien, *Wilson 363* (A, MO, US), *502* (A, F,

GH, MO, US); Patung Hsien, *Ho-Ch'ang Chow 901* (A, NY); Wan-tsao Shan, *Chun 3884* (A), *4229* (US); without precise locality, *Henry 7614* (GH). KIANGSI: Hsin-feng Hsien, *Hu 1119* (A); Lu-shan, *Chung & Sun 592* (A, NY), *Steward 1234* (A), *5470* (A, UC, US), *Wilson 1519* (A, MO, US). KIANGSI ET FUKIEN: in monte Dunghwa-schan inter Schitscheng et Ninghwa, *Wang 299* (A). KWANGSI: Tunghua Shan, Thwang, *Tsiang 10047* (NY); Tzu-yuen Hsien, *Chung 83605* (A); Huangtung, Yao-shan, *Sin 11835* (NY). KWANGTUNG: Jen-hwa Hsien, *Tsang 26404* (A); Lokchong, *Chun 42959* (A), *Tsang 20855* (A, L, MO, NY, SING, UC, US), *Tsiang 1346* (A, isotype of *C. lokchongensis*, UC), *1419* (A, UC); Tsungfa, *Tsang 25189* (A); Yang-shan Hsien, *Tsui 763* (MO, NY). KWEICHOW: Nan-kan, Cheng-feng, *Tsiang 4661* (A, NY); Pinfa, Kweiting, *Tsiang 5360* (A, NY); Tsingchen, *Teng 90254* (A); Tungtze, *Chun 5013* (A, S, UC), *Tsiang 5013* (NY); Yao-ren Shan, Sanhoa, *Tsiang 6450* (A, NY); without precise locality, *Esquirol 4* (A, type of *Embelia Esquirolii*). SIKANG: Kangting (Tachien-lu), *Smith 12898* (S), *Wilson 1302* (A, MO, US). SZECHUAN: Kuan Hsien, *Fang 2124* (A, NY); Mo-tien-ling, *Wang 22451* (A); Monkong-ting, *Wilson 2305*[A] (A); Mow Hsien, *Fang 5529* (A); Nan-chuan Hsien, *Fang 593* (A); Omei Shan, *Chow 9906* (A), *Fang & Lee 3575* (A, US), *Yu-shih Liu 1147, 1423* (A), *Tai 1113, 1120* (A); O-pien Hsien, *Sun 781* (A); Pao-Hsing Hsien, *Chu 3761* (A); Wen-chuan Hsien, *Wilson 2305* (A, MO, US); Yun-ching Hsien, *Sun 1247* (A). YUNNAN: Chien-chuan-Mekong Divide, *Forrest 21464, 22311* (A, US); Chungtien, *Feng 2868* (A), *Rock 24679* (A, MO, NY, UC, US); in the mountain above Dashao, *Handel-Mazzetti 13074* (A); between Kambaiti and Tengyueh, via Kuyung, *Rock 7568* (A, UC, US); Kunming, *Wang 62990* (A); Likiang *Ching 20682* (A), *Rock 3799* (A, UC, US), *4195* (A, US); Mengtze, *Henry 9782* (A, NY), *9782*[A] (A, type of *C. gemmatus;* MO), *10531* (A, paratype of *C. gemmatus;* MO, NY, US), *11471* (A, paratype of *C. gemmatus;* MO, NY); Muli Wachin, *Yu 14375* (A); Ping-pien Hsien, *Tsai 61004* (A); south of Red River from Manmei, *Henry 9679*[A] (A); between Shweli and Yengyueh valleys, *Forrest 8704* (A, S), *11173, 12050* (A); Suen-oui, *Maire 14* (A); Tali, *Rock 6809* (A, US); Tai-pon, *Maire 102* (A); Wei-si Hsien, *Tsai 59523, 59799, 63116* (A), *Wang 63709* (A); without precise locality, *Ducloux 132* (NY, UC), *Forrest 16241, 14510* (A), *Yu 5562, 5771* (A).

Celastrus gemmatus often has been confused with *C. orbiculatus* Thunb., since the two are closely related. After a careful examination of specimens of the two species, it was found that although their floral morphology is similar, *C. gemmatus* has larger conic axillary buds, firmly membranaceous and densely reticulated leaves, and, in addition, a distinct geographical distribution which separates it from *Celastrus orbiculatus* and other related species. *Celastrus gemmatus* is chiefly distributed in southwestern China and is rarely found in southeastern China; some plants are recorded as far north as Hupei which may represent its northern limit.

I have seen the types of *Embelia esquirolii* Lévl. and *C. lokchongensis* Masamune, They both bear large conical axillary buds and densely reticulated leaves, and are within the geographical range of *Celastrus gemmatus*. Hence, I consider these species as synonyms of *Celastrus gemmatus*.

17. CELASTRUS ORBICULATUS Thunb. Fl. Jap. pp. xlii, 97 (errore "*articulatus*"). 1784; Gmel. Syst. Veg. 406. 1796; Lam. Tab. Encycl. et Meth. Bot. 2:94. 1797; Airy Shaw, in Curtis's Bot. Mag. 158:*tab. 9394.* 1935. (T.: *collector unknown s. n.*, A, photo!).

Celastrus articulatus Thunb. Fl. Jap. 97. 1784 (sub. *Celastrus orbiculatus*, quoad nomen apud Thunb. in Fl. Jap. p. xlii); Maxim. in Bull. Acad. Sci. St.-Petersb., III, 27:456. 1881; Mel. Biol. Acad. St.-Petersb. 11:200. 1881.

Celastrus tatarinowii Rupr. in Bull. Acad. Sci. St.-Petersb., II, 40:357. 1857, ex char.

Celastrus punctatus sensu Regel, in Gartenfl. 9:407, *tab. 312, f. 6.* 1860, non Thunb.
Celastrus articulatus Thunb. var. *pubescens* Makino, in Bot. Mag. Tokyo 7:102. 1893, ex char. (T.: *Makino s. n.*).
Celastrus orbiculata Thunb. forma β. *microphylla* Loes. in Engl. Bot. Jahrb. 30:469. 1901, ex char. (T.: *Henry 3827*).
Celastrus orbiculata Thunb. forma γ. *maior* Loes. loc. cit. 30:469. 1901, ex char. (T.: *Giraldi 237*).
Celastrus articulata Thunb. var. *cuneata* Rehd. & Wils. in Sarg. Pl. Wils. 2:350. 1915. (T.: *Wilson 2308*, A!).
Celastrus lancifolia Nakai, in Bot. Mag. Tokyo 37:3. 1923, ex char. (T.: *Nakai s. n.*).
Celastrus insularis Koidz. in Bot. Mag. Tokyo 39:22. 1925, ex char. (T.: *Koidzumi s. n.*).
Celastrus strigillosus Nakai, loc. cit. 40:492. 1926, ex char. (T.: *Nakai s. n.*).
Celastrus articulatus Thunb. var. *stephanotiifolius* Makino, in Jour. Jap. Bot. 3:24. 1926, ex char. (T.: *Makino s. n.*).
Celastrus stephanotiifolius (Makino) Makino, loc. cit. 3:46. 1926.
Celastrus orbiculata var. *aureo-arillata* Honda, in Bot. Mag. Tokyo 45:422. 1931, ex char. (T.: *D. Shimisu 50*).
Celastrus jeholensis Nakai, apud Nakai & Kitagawa, in Rept. 1st. Scientif. Exped. Manchoukuo, Sect. IV, 1:6, *pl. 1.* 1934, ex char. (T.: *Nakai et al. s. n.*).
Celastrus articulatus var. *papillosus* Nakai ex Hara, in Jour. Jap. Bot. 10:84. 1934, ex char. (T.: *H. Hara s. n.*).
Celastrus articulata var. *orbiculata* (Thunb.) Wang, in Chin. Jour. Bot. 1:62. 1936.
Celastrus orbiculatus var. *papillosus* (Nakai) Ohwi, Fl. Jap. 736. 1953.
Celastrus versicolor Nakai, in Bull. Sci. Mus. Tokyo 33:16. 1953, ex char. (T.: *Nakai & Maruyama s. n.*).
Celastrus orbiculatus var. *pilosus* Nakai, loc. cit. 33:16. 1953, ex char. (T.: *Hozawa-Sigeo s. n.*).
Celastrus orbiculatus f. *papillosus* Nakai ex Hara, Enum. Spermat. Japon. 80. 1954.

Scandent shrubs up to 10 or 12 m. tall; branches terete to slightly striate, glabrous, light to darkish brown, the lenticels inconspicuous or sparse; axillary buds small, depressed, ovoid to subglobose, 1–3 mm. long, sometimes the outermost scales becoming deltoid, sharp-spinose, 1–2 mm. long. Leaves extremely variable in size and shape, usually obovate to suborbicular, ovate, or oval-oblong, the apex rounded, shortly cuspidate to acute, the base cuneate to obtuse, the margins crenate-serrate, 2–12 cm. long, 1.5–8.0 cm. wide, delicately membranaceous, glabrous above, rarely puberulent below, the primary lateral veins 3–6 pairs, distinctly elevated below, slightly elevated above, the veinlets slightly reticulated, prominent and slightly elevated below, immersed and obscure above; stipules filiform, tufted, about 1–2 mm. long; petioles 1–3 cm. long. Inflorescences axillary, rarely also terminal in the male plant, usually 3- to 7-flowered, occasionally solitary, often rather congested along the shoots of the current year, the subtending leaf sometimes not developed, distinctly pedunculate, the peduncles subequal, glabrous, the primary peduncles 3–8 mm. long; flowers yellowish-green, regularly dioecious, but occasionally monoecious in late growth, the pedicels about 2–3 mm. long, accrescent, the articulation usually at the base or lower third of the stalk. Male flowers: calyx lobes open, ovate-deltoid, subacute to obtuse, glandular-ciliolate, about 1.5 mm. long; petals narrowly oblong to oblanceolate, obtuse, subentire to slightly ciliolate or erose, usually 3–5 mm. long and 1–2 mm. wide; disc thin, cup-shaped, the lobes usually acute; stamens arising from the margin of the disc proper, about

3 mm. long, the filaments filiform, glabrous, the anthers oblong-ellipsoid, obtuse, pink-punctate; sterile pistil columnar, about 2 mm. long. Female flowers: calyx, petals, and disc as in the male, sometimes the petals smaller; sterile stamens about 1.3 mm. long; pistil flask-shaped, about 4 mm. long, the ovary ovoid, narrowed into a columnar style, the stigmata 3-lobed, the lobes flat, recurved, sometimes each slightly bifid. Fruits subglobose, bright yellow, the valves broadly elliptic to suborbicular, about 6–8 mm. long and 5–7 mm. wide, 3- to 6-seeded, the pedicels usually green in dry condition. Seeds usually ovoid or ellipsoid, about 5 mm. long and 3.5 mm. wide, minutely areolate, pinkish-brown.

Common in lowland slopes or in thickets, at altitudes from 100 to 1,400 m.; widely distributed in northern and central Japan, Korea, and China; flowering from April to June.

CHINA: CHEKIANG: Hai-wei, southern I-shing, *Ching & Tso 580* (A). HARBIN: (Pinkiang), along a river, *Skvortzov s. n.*, Dec. 7, 1929 (A). HONAN: Siashih, *Hers 345* (A); Sunghsien, Shih-tze-miao, *Hers 1272* (A); Teng-feng Hsien, Yu-tai Shan, *Hers 2791* (A); Tsi-yuan Hsien, *Hers 1758, 2795* (A); Yungning, Yu-tze-ping, *Hers 828* (A); without precise locality, *Hers 26* (A). HOPEI (CHILI): Ch'o-K'ou-tien, 50 km. sw. Peking, *Bohlin 104* (S, UPS); Chang-li, *Dorsett & Morse 7152* (US); western hills, *Dorsett & Morse 7206* (UC, US); Prince Park, *Wang 176* (NY); mont. á l'ouest Peking pagoda, Pi-yun-sen, *Janet 1639* (UPS); Haiao-wu-tai Shan, *Smith 740, 959* (S, UPS); Kuan-tso-ling, *Liu 1176* (UC); Ming Tombs, Nankou, *Chiao 2126* (US); Tsing-ling-chiao, *Chiao 2116* (NY), *Dorsett & Morse 7074* (US); near eastern Tombs, *Liou 385* (NY); western Tombs, *Liu 398* (UC); without precise locality, *Li 11169* (NY). HUPEI: Ichang, *Chun 3505* (A), *Wilson 2308* (A, holotype of *Celastrus articulata* var. *cuneata* Rehd. & Wils.); Noh-chen Hsien, *Chow 369* (NY); Lo-kia Shan, Wuchang, *Sun 108* (NY); western Hupei, without precise locality, *Wilson 181* (GH, US). JEHOL (GEHOL): *David 1783* (GH, US). KANGSU: Mien Shan, Lin-shih Hsien, *Tang 889* (A); Tienschui, *Fenzel 2827* (A). LIAONING: Liaoyang, Mukden, *Li 69* (UC). PORT ARTHUR: *Wilson 8801* (A). NANKING: *Ling 1402* (UC). SHANSI: Chioh-hsin Dist., *Smith 5745* (A, S, UPS), *7697* (A, UPS); Chin-yuan, *Ling 1607, 1664* (UC); Fu-ping, Tao-ho-tze, *Janet A348* (UPS); Fu-ping, Ta-wu-tai Shan, *Janet A349* (UPS); Hweihsien, Shansi border, *Hers 704* (A); Tsing-huy, *Janet A79* (UPS); Dao-hui-gou, Wenshui, *Wang 174* (GH); Yuan-chu Dist., Yang-shu-ling, *Smith 6154* (UPS). SHANGTUNG: Meng Shan, Fei Hsien, *Cheo & Yen 193* (A); Tsing-tao, First Park, *Chiao 2395* (A, NY, US), *2612* (A, F, NY, UC, US); Tsing-tao, *Lioent 13262* (A); Tsinan, Ching-lung Shan, *Chiao 3016* (A, NY, UC, US). SHENSI: Lao-y-san, *Giraldi s. n.*, June 5, 1897 (A, UC); Tai-pei-shan, *Purdom 944* (A, US), *945* (A); Tsingling-shan centr. inter Mei et Liupa, *Fenzel 502* (A).

JAPAN: HONSHU: Chiba Pref., Mobara, *Walker 5717* (US); Kanagawa, Hakone in Sagami, *Ohwi & Okamot 504, 506* (L, S, UC, US); Hakone, *Sawada 2161* (S); Mt. Tanzawa, *Suzuki 479013* (UC); Mino (Gifu), *Shiota 3899, 3905, 9643, 9766* (A); Prov. Musashi, *Hurusawa 10650* (MO), *Yamazala 44* (US); Prov. Nagano, *Kimura 307* (US), *Suzuki 455009* (UC); Niigata, Sado, *Faurie 2502* (MO); Nikuko, Shimotsuke, *Wilson s. n.*, 1914 (A); Otake-gawa, Shinano Prov., *Wilson s. n.*, 1914 (A); Suruga Prov., *Wilson 6907* (A, MO, US); Oku-shiobara, Tochigi, *Suzuki 444020* (UC); Tokyo, *Faurie 6134* (A), *Yamazala 44-A* (US); Kamohura, Sagami Prov., *Wilson 6627* (A, US); Kumashii, Tomari, Toyama, *Bergman 439* (S); Prov. Ugo, *Mizushima 1929* (MO); Mitsutooge, Yamanashi Pref., *Suzuki 486024* (UC); Mt. Hoowoo, Yamanashi, *Suzuki 493027* (UC). HOKKAIDO: Prov. Iburi, Zezo, *Takenauchi s. n.*, July 17, 1916 (S); Sapporo, *Faurie 6133* (A), *Jack s. n.*, Aug. 22, 1905 (A, GH), *Miyabe s. n.*, June 1880 (A, GH), *Wilson 7412* (A); vicinity of Obihiro, Tokachi, *Dorsett & Morse 1070* (A, US); southern Hokkaido,

without precise locality, *Brooks 44* (A, UC), *544* (UPS). KURILE ISLANDS: Shikotan, *Obwi 436* (UPS). WITHOUT PRECISE LOCALITY: *Thunberg s. n.* (A, type photo of *C. orbiculatus, pl. 961*).

KOREA: Port Chusan, Keisho Nan, *Wilford s. n.*, 1859 (GH, S); Port Hamilton, *Wilford s. n.*, 1859 (GH, S); Keijo (Seoul), *Mills s. n.*, Oct. 2, 1915 (UC); Kongo-san, Prov. Kogen, *Wilson 10461* (US); Pyongang, *Wilson 9203* (US); Taiyudo Prov., Hsian Hoku, *Wilson 8611* (US); without precise locality, *Gilbert 6* (UC).

Thunberg describes this species (Fl. Jap. p. 97, 1784) as *Celastrus articulatus*. However, in his index, p. xlii, *articulatus* is omitted and *orbiculatus* is listed. In 1796, Gmelin[32] used the name *orbiculatus* and referred to Thunberg's Fl. Jap. p. 97, but he did not mention *articulatus*. Later, in 1881, Maximowicz pointed out[33] that the name *articulatus* was due to a printer's error, having been changed from *C. orbiculatus*, as shown in the 'Flora Japonica' and the figures of Thunberg's manuscript. However, Maximowicz chose *Celastrus articulatus* as the species name because it was universally accepted at that time. Airy Shaw[34] states in 1935 that "The form *articulatus* is a 'vain tradition', and the sooner it is dropped the better—but tradition dies hard!" I agree that it is best to use the originally correct name for this species, even more so because "orbiculatus" refers to the leaf shape.

This is a very widely distributed eastern Asiatic species. It is found in northern and central Japan, and provinces north of the Yangtze River in China. The Yangtze River seems to be the southern limit of its distribution, except for a few specimens that have been collected south of the river (northern Chekiang).

It is the commonly cultivated and nearly naturalized exotic *Celastrus* of the eastern United States where it was introduced at the New York Botanical Garden in 1891 from seeds secured from the Royal Botanic Gardens, Kew[35]. The fruit-clusters are axillary and remain attractive through the winter after the leaves have fallen; the fruiting branches are as showy as those of the paniculiform *Celastrus scandens*. Birds are fond of the ripe seeds[36] and help to propagate them.

I have observed two living plants of this species cultivated in the Missouri Botanical Garden. In the spring both have male flowers; all the floriferous branches bear both axillary and terminal inflorescences. In June, the male flowers fall, and the terminal inflorescences fall away from the plant; some of the axillary buds or buds that are near the top of the branchlets sometimes now develop into shoots which bear only female flowers. Some of the female flowers develop into fruits which in these plants are scarce. The leaves are variable. Due to the variation caused by these characteristics, there are many synonyms for this species.

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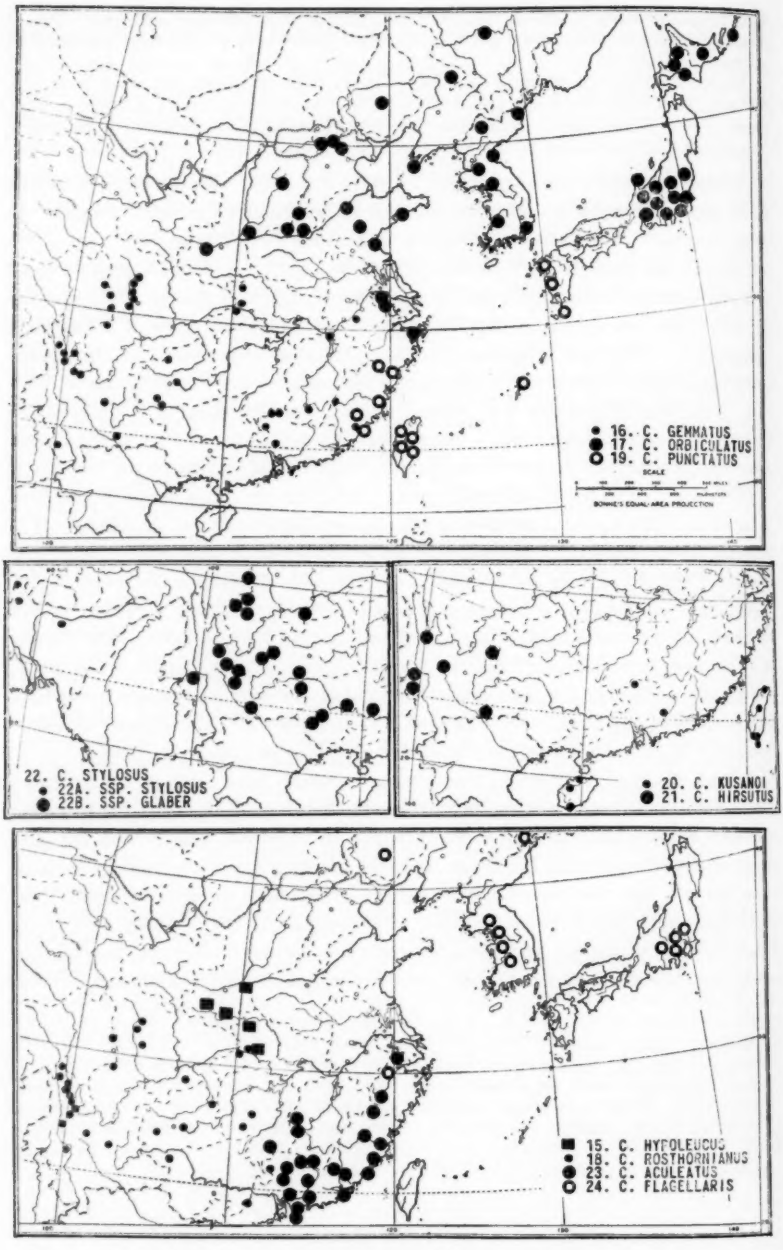
[32] Syst. Veg. p. 406. 1796.
[33] Mél. Biol. Acad. St. Pétersb. 11:201. 1881.
[34] Curt. Bot. Mag. 158:*tab. 9394*. 1935.
[35] Nash, C. V. *Celastrus articulatus*. Addisonia 4:9–10, *pl. 125*. 1919.
[36] Burbidge, F. W. Japanese tree-strangler, or staff tree *(Celastrus articulatus)*. Gard. Chron. III, 23:28, *f. 11*. 1898.



Map 3. Distribution of ten species of *Celastrus*, Subgenus CELASTRUS, Series II. AXILLARES.

18. CELASTRUS ROSTHORNIANUS Loes. in Engl. Bot. Jahrb. 29:445. *tab. V. F-H.* 1900. (T.: *Rosthorn 1572*, A, photo!).

Celastrus stylosa sensu Lévl. Fl. Kouy-Tchéou, p. 69. 1914, non Wall.
Celastrus loeseneri Rehd. & Wils. in Sarg. Pl. Wilson. 2:350. 1915. (T.: *Wilson 357*[a], A!).
Celastrus cavaleriei Lévl. in Monde des Pl. II, 18:31. 1916. (T.: *Cavalerie 496*, A, photo!), non Lévl. 1914.

Scandent shrubs up to 7 m. tall; branches terete, occasionally striate, glabrous, gray-brown to brown-red, densely to sparsely lenticelled, the lenticels elevated, ovate; axillary buds ovoid, about 3 mm. long. Leaves elliptic, oval, or obovate-oblong, the apex acute, the base cuneate to obtuse, the margins remotely serrulate to serrate, usually 4–11 cm. long, 2–6 cm. wide, thinly membranaceous on the flowering specimens, firmly membranaceous on the fruiting specimens, glabrous, the primary lateral veins 4–7 pairs, prominent, slightly elevated on both surfaces, the veinlets obscure on both surfaces; stipules filiform, tufted; petioles 0.5–1.5 cm. long. Inflorescences axillary as well as terminal in the male plants, axillary only in the female, the terminal portion sometimes up to 5 cm. long, usually fascicular, rarely solitary; peduncles glabrous, the primary peduncles very short to nearly obsolete in the fascicular inflorescences, 2–5 mm. long at the solitary ones; flowers dioecious, yellowish-green, the pedicels 2–5 mm. long, the articulation at the middle or lower half of the stalk. Male flowers: calyx lobes valvate, ovate to oblong, obtuse, subentire or glandular-ciliate, about 3 mm. long and 1 mm. wide; stamens arising from the margin of the disc proper, 2.5 mm. long, the filaments filiform, glabrous, the anthers ovoid, obtuse, slightly brownish-punctate; sterile pistil subulate columnar, about 1.5 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens about 1.3 mm. long; pistil about 3.5 mm. long, the ovary subglobose, the style about 1.8 mm. long, the stigmata 3-lobed, each deeply bifid, filiform. Fruits subglobose, the valves broadly elliptic, about 7 mm. long and 6 mm. wide, 3- to 6-seeded; seeds ovoid or ellipsoid, about 4 mm. long and 2 mm. wide, the areolae distinct, yellowish-brown.

Chiefly in thickets, at altitudes from 400 to 3,400 m.; China; flowering from April to May.

CHINA: HUPEI: Bo-moh-ping, *Chun 3570* (A); Changyang, *Wilson 688* (A), *706* (NY); Hsing-shan Hsien, *Wilson 357*[a] (A, type of *Celastrus loeseneri* Rehd. & Wils.; GH, MO), *560*, *2309* (A, US), *Chen 1090* (UC); Kui, *Wilson s. n.*, June 1907 (NY); Patung Hsien, *Ho-chang Chow 315*, *572* (A, NY), *Wilson 503* (A, US); without precise locality, *Henry 315* (A, GH), *5909* (GH, NY, US). HUNAN: Hsikwang Shan, *Handel-Mazzetti 583* (A); Hsinhwa, *Handel-Mazzetti 810* (A); Wukang, *Te-Hui Wang 114* (A). KWANGSI: Lin-yuin Hsien, *Steward & Cheo 429* (A, NY); Ling Wun, *Lau 28207*, *28763* (A); Ling-yun Hsien, *Lau 28558* (A). KWANGTUNG: Suny, *Wang 32148* (A); Yang-shan Hsien, *Tsui 542* (A, MO, UC, US). KWEICHOW: Anlung, *Tsiang 9354* (A, NY); Kiang-kow, *Tsiang 7499* (A, NY); Kweiting, *Tsiang 5443* (A, NY), *5614* (A); Lang-tai, Yeh-tin, *Tsiang 9513* (A, NY); Wai-ho, near Sio-chang, *Tsiang 5601* (A); without precise locality, *Cavalerie 496* (type of *Celastrus cavaleriei*, photo, A). SIKANG: near San-tao-chiao, 40 li from I-tung, *Chiao 1720* (A); Konting (Tachien-lu), *Wilson 4187* (A); Tienchuan, *Fang 3424* (A), *3486* (A, NY). SZECHUAN: Chao-hua Hsien, *Hopkinson 297* (S); Chengtu, *Chien 5920* (A), *Feng 19884* (A); Chin-ting Shan, *Wilson 2311* (A); inter Kuapie et Tahao-ko, *Schneider 1375* (A); Mian-ning

Hsien, *Yu 1756* (A); Mow Hsien, *Fang 5589* (A, NY); Nan-chuan, *Rosthorn 1572* (type, photo of *Celastrus rosthornianus*, A), *1753* (A, paratype of *C. rosthornianus*); Ning-yuen, *Handel-Mazzetti 1305* (A); Telipu, *Schneider 1131* (A); Tien-chuan, *Yu-shih Liu 1319* (A); Wen-chuan Hsien, *Wilson 1175* (A, US), *4159* (A); inter flumina Yalung et Nganning-ho, *Handel-Mazzetti 2008* (US); Omei Shan, *Chow 5707* (A), *Chow 11742, 12013* (A), *Chu 3701* (A), *Fang 16419, 17795* (A), *Lee 2805* (A), *3069* (A, US), *Wilson 4781* (A); without precise locality, *Faber 227* (NY), *Henry 5640* (A, GH, MO), *5734* (GH, NY). YUNNAN: A-tun-tze, *Wang 69361* (A), *Yu 7978* (A); Chung-tien, *2428, 2479, 3262* (A); La Kou, *Maire 3633 ser. B* (A, NY, UC); Lapping Hsien, *Tsai 56096* (A); Liang-shan, *Tsai 51340, 51343* (A); Likiang, *Ching 22119* (A), *Forrest 21201* (A, US), *Rock 3885* (A, US), *8312* (NY, UC, US); Mar-li-po, *Feng 13124, 13369* (A); Mekong, *Rock 6946* (A, UC, US); Mienning, Poshang, *Yu 17893* (A); Muli, near Lama-sery, *Yu 14848* (A); Pan-pien-kai, *Maire 7256* (UC); Pin-chuan Hsien, *Tsai 52901* (A); Ping-pien Hsien, *Tsai 60781* (A); Si-chour Hsien, *Feng 11720, 12084* (A); Shun-ning, *Wang 71910* (A); Suen-oui, *Maire 81* (A); between Sung-kweh and Tengchuan, *Schneider 2683* (A, GH, NY); Tso-si, *Maire 254* (A); Wei-se Hsien, *Tsai 57974, 59548, 61753, 63059, 64147, 68293* (A); without precise locality, *Forrest 7812, 16226* (A); *Tsai 57253, 57271, 57343, 57510, 57769, 60933* (A); *Yu 5185, 7204, 5845* (A).

This is a common species chiefly distributed in southwestern and central China. Since the leaf characters are quite variable, this species has sometimes been misidentified. However, the characters of the flower, fruit, and seed are constant. The racemiform inflorescences bear clustered, usually sessile flowers; the disc-lobes are subquadrate, broader than long, and mucronate; and the seeds are ovoid or ellipsoid and usually yellowish-brown. These characters can distinguish *Celastrus rosthornianus* from related species.

Léveillé first identified a specimen collected by Cavalerie (no. *496*) from Kweichow as *Celastrus stylosa* Wall., and later described it as a new species *C. cavaleriei* (non *Léveillé 1914*) although he had previously published the same name based on another specimen. The earlier name subsequently was shown by Rehder[37] to be a *Myrsine*. I have seen the type photo of the *Cavalerie 496* specimen, and it compares closely with others collected in Kweichow. They are all fruiting specimens, and clearly belong to *Celastrus rosthornianus*. These Kweichow plants have grayish-brown, striate-fissured branches, and remarkably uniform, elliptic, firmly membranous leaves. This uniform population perhaps could be considered as an ecotype.

19. CELASTRUS PUNCTATUS Thunb. Fl. Jap. 97. 1784. (T.: *Collector unknown, s. n.*, A, photo!).

Celastrus scandens sensu Thunb. in Trans. Linn. Soc. 2:332. 1794, non L.
Celastrus punctulatus in Abh. Bayer. Akad. Muench. II, 4:150. 1845 (apparently an error for *punctatus*).
Celastrus crispulus Regel, in Gartenfl. 9:407, *tab. 312, f. 1–5*. 1860, ex char. & ill.
Celastrus striatus Miq. in Ann. Mus. Bot. Lugd.-Bat. 2:210. 1865–66, non Thunb., ex char.
Celastrus kiusianus Franch. & Sav. Enum. Pl. Jap. 2:314. 1879, ex char. (T.: *Savatier 3528*).
Celastrus orbiculatus var. *punctatus* (Thunb.) Rehd. in Bailey, Cycl. Am. Hort. 1:267. 1900.
Celastrus articulatus Thunb. var. *punctatus* (Thunb.) Makino, in Bot. Mag. Tokyo 21:138. 1907.

[37] Jour. Arn. Arb. 15:292. 1934.

Celastrus gracillimus Hay. Icon. Pl. Formosa. 5:24. 1915. (T.: *Hayata s. n.* A, photo!).
Celastrus leiocarpus Hay. loc. cit. 5:22. 1915. (T.: *Mori s. n.*, A, photo!).
Celastrus longe-racemosus Hay. loc. cit. 5:23, *pl. 3*. 1915. (T.: *Hayata s. n.*, TAI!).
Celastrus geminiflorus Hay. loc. cit. 5:25, *f. 9*. 1915. (T.: *Nagasama s. n.*, A, photo!).
Celastrus elevativenus Hay. loc. cit. 6:14. 1916. (T.: *Faurie s. n.*, A, photo!).
Celastrus punctatus Thunb. var. *microphyllus* Li & Hou ex Hou, in Taiwania 1:172. 1950. (T.: *Yamamoto 802*, TAI!).

Scandent shrubs, about 2–3 m. tall; branches terete, glabrous, hazel-brown, the lenticels rounded or oval, scattered and elevated; axillary buds deltoid, about 2 mm. long, the outermost bud scales sometimes sharply spinose. Leaves usually elliptic, the apex acute, the base usually cuneate, the margins remotely serrate, 2–7 cm. long, 0.8–3.0 cm. wide, membranous, glabrous, the primary lateral veins 4–5 pairs, slightly elevated below, immersed above, the veinlets obscure to distinct; stipules filiform, tufted, about 2 mm. long; petioles about 0.5–1.0 cm. long. Inflorescences axillary as well as terminal in the male plant, axillary only in the female, fasciculate, racemiform, or solitary, the peduncles obsolete, glabrous, the primary peduncles suppressed to about 5 mm. long; flowers dioecious, white or pale green, the pedicels 1.0–1.5 mm. long, the articulation at the middle or upper third of the stalk. Male flowers: calyx lobes open, deltoid to oblong, obtuse, glandular-ciliate, about 1 mm. long; petals usually oblong to slightly obovate-oblong, ciliate to slightly erose, 2.5–4.5 mm. long and 1.3–1.5 mm. wide; disc cupuliform, the lobes erect, oblong, about half to one-third as long as the disc proper, obtuse; stamens arising from the margin of the disc proper, the filaments filiform, glabrous, the anthers broadly ovoid, obtuse, the base divided to above the middle, pink-punctate; sterile pistil subconical-columniform, slightly 3-lobed, about 1.5 mm. long. Female flower unseen. Fruits globose or subglobose, usually solitary, fasciculate, sessile or occasionally short-pedunculate, pale yellow when dried, the valves suborbicular, about 6 mm. in diameter, 3- to 6-seeded; seeds broadly ellipsoid, about 2 mm. long, smooth, pinkish-brown.

Hillsides and in thickets, at altitudes from 100 to 2350 m.; southeastern China, Riukiu Islands, and southern Japan; flowering from March to August.

CHINA: ANHWEI: Chu-hwa Shan, *Ching 2661* (UC). CHEKIANG: Changhua, *Keng 567* (A, UC); south of Siachu, *Ching 1677* (MO, NY, UC, US). FUKIEN: Amoy, *Chung 493* (SING), *1437*, *1447*, *1491* (A, UC), *1515* (UC), *4604* (A, NY), *5957* (A); Diongloh, *Ping En Chen 2447*, *2701* (UC), *Siu Ging Tang 13657* (UC); Foochow, *Siu Ging Tang 1677*, *7085* (A, UC); Kushan, *Dunn 44* (A); Mt. Useke, *Nagasawa s. n.* (A, photo of type of *C. geminiflorus*). TAIWAN: Arisan, *Gressitt 141* (A, L, NY, S, U), *185* (A, L, NY, S, U), *Hayata s. n.*, April 26, 1914 (TAI, photo of type of *C. longe-racemosus*; A), *s. n.* (A, photo of type of *C. gracillimus*); Nanko-taisan, *Sasaki s. n.*, July 22, 1922 (A, photo); Kwarenko, *Faurie s. n.* (A, photo of type of *C. elevativenus*), *Nakamura 3618* (TAI); Shinchow, Prov. Karenko, *Wilson 11096* (A, US); Taito, *Mori s. n.* (A, photo of type of *C. leiocarpus*); Mt. Taito, *Yamamoto 802* (type of *C. punctatus* var. *microphyllus*, TAI).

JAPAN: KYUSHU: Mt. Kirishima, *Tashiro s. n.*, May 5, 1917 (A); Kudsi Kadsura, *Tsuro Ome* (?) *500* (A); Nagasaki, *Oldham 161* (GH, L, S), *162* (GH), *Wilson 6304* (A); Satuma, *Suzuki s. n.*, Aug. 13, 1930 (TAI); Tanegashima, Kita-tane, *Mori s. n.*, Aug. 13, 1934 (TAI); Tanaga-shima, *Wilson 6121* (A).

RIUKIU ISLANDS: *Wright 54* (GH).

The type of *Celastrus longe-racemosus* is a flowering specimen whereas the type of *C. punctatus* var. *microphyllus* is a fruiting specimen. Until now no fruiting or flowering specimens, respectively, for these two species have been found. On further examination of additional specimens, it was observed that the fruiting branchlets of the type of *C. punctatus* var. *microphyllus* are the same as the so-called long-racemose inflorescences of *C. longe-racemosus;* consequently, they appear to belong to the present species because they cannot be distinguished from it. On comparing material from Fukien and southern Japan, this interpretation is confirmed by both morphological characters and geographical distribution.

In general appearance, the present species differs conspicuously from *Celastrus orbiculatus* and more closely resembles *C. rosthornianus*. However, the deeply cleft, oblong disc lobes, the articulations located at the upper third or half of the stalk, as well as the distinct geographical distribution distinguish this species from related ones.

20. CELASTRUS KUSANOI Hayata, in Jour. Coll. Sci. Imp. Univ. Tokyo 30:60. 1911; Icon. Pl. Formos. 1:137. 1911; 5:20. *t. 8.* 1915, ex char. & ill. (T.: *Kusano s. n.*).

Scandent shrubs up to 18 m. tall; branches terete, sometimes striate, brown, the branchlets glabrous to brownish-pubescent, both sparsely or rarely densely lenticelled, the lenticels orbicular or ovate; axillary buds deltoid, about 2.5 mm. long. Leaves broadly elliptic to nearly orbicular, rarely elliptic, the apex rounded to shortly cuspidate, the base broadly truncate, rarely obtuse to cordate, 5.0–10.5 cm. long, 5–11 cm. wide, chartaceous, glabrous or pubescent on the veins below, the primary lateral veins 5–7 pairs, slightly elevated on both surfaces, the veinlets distinct below, obsolete above; petioles usually 1.5–2.5 cm. long, rarely up to 5 cm. long; inflorescences axillary and cauline at the basal position of the current year's growth, rarely also terminal in the male plant, usually 3- to 7-flowered, the peduncles usually pubescent, sometimes yellow, the pedicels about 3–5 mm. long, usually pubescent, the articulation nearly toward the base of the stalk. Male flowers: calyx lobes deltoid, obtuse, entire, about 1 mm. long; petals obovate to oblong, rounded, about 4 mm. long and 1.5 mm. wide, ciliate, sometimes pubescent within on the lower portion; disc subfleshy, flat, the lobes obscure, truncate; stamens arising from the margin of the disc, about 3 mm. long, the filaments filiform, papillose-tuberculate, the anthers ovoid, subcordate; sterile pistil conical, about 1 mm. long. Female flowers: calyx, petals, and disc as in the male; sterile stamens about 1.5 mm. long; pistil about 3.3 mm. long, the ovary subglobose, the style columnar, the stigmata 3-lobed, reflexed. Fruits globose or subglobose, the valves suborbicular or broadly elliptic, about 8–10 mm. long and 5–7 mm. wide, 3- to 6-seeded; seeds slightly lunate, minutely areolate, dark brown.

Chiefly in thickets, at altitudes from 100 to 1,000 m.; southeastern China; flowering from February to April.

CHINA: HAINAN: Bak Sa, *Lau 26184, 26606* (A); Ching-mai Hsien, *Lei 309* (A, NY, SING, UC, US); Fan Yah, *Chun & Tso 44028* (A, F, NY, US). KWANGTUNG:

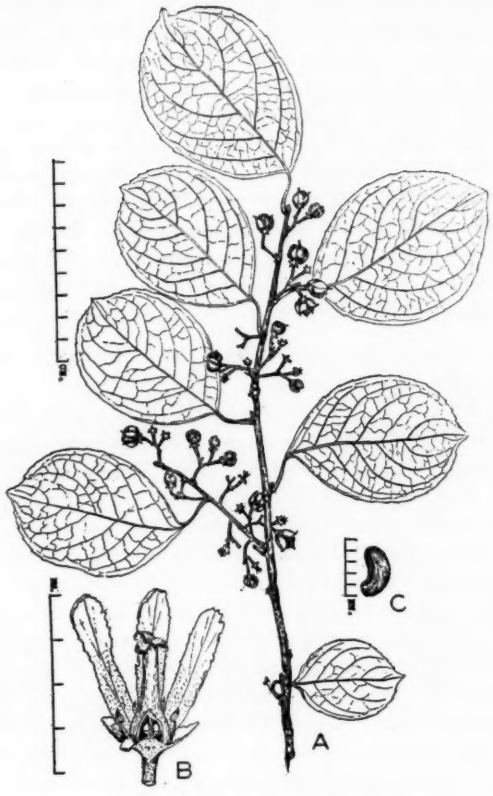


Fig. 10. *Celastrus kusanoi* Hayata

Lokchong, *Tsiang 1393* (A, UC), *Tso 20788, 20796, 21026* (NY); Tsinleong Shan, Mei Hsien, *Gressitt 1240* (A, MO); Lung-t'au Shan, Iu village, *Kang-peng To 131* (UC), *442* (MO, UC); Nam Shan, Ho-yuen Hsien, *Tsang 28927* (A); Ying-tak, *Kang-peng To & Kam-chow Wong 2784, 2928* (UC). TAIWAN: Arisan, *Faurie 1374* (A); Kosyun, *Kudo & Suzuki 16048* (TAI), *Suzuki 6195* (TAI); Kuaru, *Yamada 1215* (TAI); Mt. Naier, Bansyoryo, *Kawakami & Mori 3145* (TAI); Nanto, *Wilson 9981* (A); Taipei, *Wilson 11214* (A); Takou, Apes Hill, *Henry 1893* (A, NY, TAI).

Henry[38] first regarded the Formosan specimen, collected by himself (no. *1893*), as a variety of *Celastrus articulatus* Thunb., but did not give it a name. Later Hayata described a specimen collected by Kusano as *Celastrus kusanoi* Hayata, but he did not cite Henry's specimen. He stated that *Celastrus kusanoi* is near *C. articulatus (C. orbiculatus)* but differs from it in having more rounded leaves and

[38] A List of Plants from Formosa. p. 27. 1895.

carpels transversely wrinkled in the dried condition. His original description was based on a fruiting specimen; later[39] he obtained a flowering specimen, and then amplified his description. *Celastrus kusanoi* bears pubescent filaments, lunate seeds and usually nearly rounded leaves, hence it is easily distinguished.

Specimens collected from central and southern Formosa have nearly rounded and sometimes even cordate leaves, whereas those from Hainan and Kwangtung usually bear suborbicular or broadly obovate leaves without cordate bases.

Merrill and Chun[40] have said that Kwangtung records of *Celastrus articulatus* Thunb. (*C. orbiculatus* Thunb.) actually belong to *C. kusanoi* Hay. and that Thunberg's species does not extend as far as Kwangtung. Of the many Kwangtung specimens labelled *Celastrus articulatus* which I have examined, none of them actually is that species; they are either *Celastrus kusanoi* Hay. or *C. gemmatus* Loes.

21. Celastrus hirsutus Comber, in Notes Roy. Bot. Gard. Edinb. 18:233. 1934, ex char. (T.: *Forrest 17963*).

Scandent shrubs up to 12 m. tall; branches terete or slightly compressed, sometimes more or less sulcate, densely brownish-pubescent or glabrescent, the lenticels elevated, large, ovate, elliptic or orbicular, rarely lacking on the current year's growth; axillary buds ovoid, usually about 3 mm., rarely 5 mm., long, the bud scales accrescent, sometimes persistent. Leaves broadly ovate to obovate, the apex round, shortly cuspidate, the base rotund or broadly cuneate, the margins crenate-serrate, 7–14 cm. long, 4–10 cm. wide, membranous, densely pubescent on both surfaces especially so on the veins when young; primary lateral veins 6–7 pairs prominently elevated below, slightly elevated above, the veinlets distinct below, immersed to obscure above; stipules laciniate, about 1 mm. long; petioles pubescent, about 1.5–3.0 cm. long. Inflorescences axillary and cauline at the basal portion of the flowering branch, usually 7- to 14-flowered, the peduncles hirsute, the primary peduncles 5–15 mm. long; flowers dioecious, creamy-white to greenish-yellow, the pedicels 3–5 mm. long, the articulation toward the base of the stalk. Male flowers: calyx lobes valvate, deltoid, obtuse, sparsely ciliate and pubescent without, about 1 mm. long; petals obovate-oblong, puberulous at the basal portions of both surfaces, about 3.5 mm. long and 2 mm. wide, obtuse, slightly erose; disc membranous, slightly concave, the lobes arcuate, distinct; stamens arising between the disc lobes, about 2.5–3.5 mm. long, the filaments subulate, papillose-tuberculate, the anthers ovoid, obtuse, cordate; sterile pistil small, ovoid, about 1.3 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens about 1 mm. long; pistil 3–5 mm. long, the style columnar, the stigmata conspicuously 3-lobed. Fruits subglobose, the valves broadly elliptic, about 8–10 mm. long and 6–8 mm. wide, 3- to 6-seeded; seeds slightly lunate, attenuate toward both ends, about 5 mm. long and 1.5 mm. wide, blackish-brown, the areolae distinct.

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[39] Icon. Pl. Formos. 5:20. 1915.
[40] In Sunyatsenia 5:111. 1940.

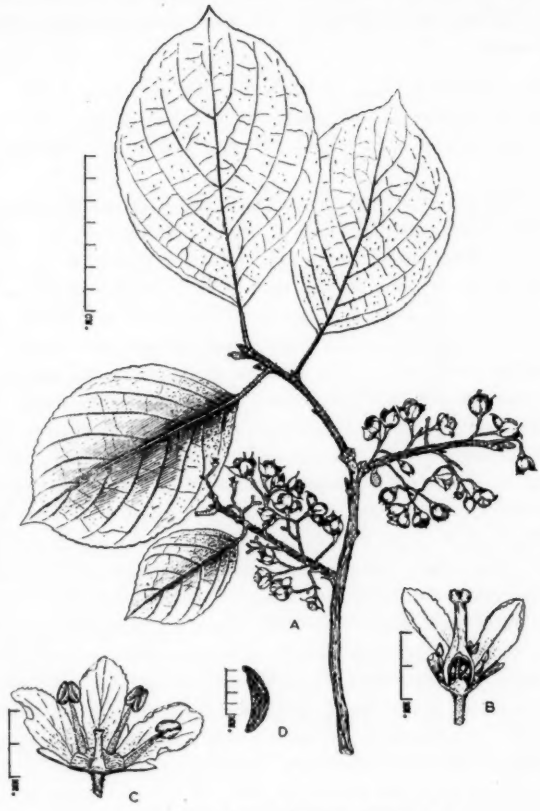


Fig. 11. *Celastrus hirsutus* Comber

In thickets, at altitudes from 1,400–2,500 m.; China, Burma, and Indo-China; flowering from March to April.

BURMA: Adung valley, 27°30′ to 28°30′ lat., and 97°30′ to 98°30′ long., *Kingdon Ward 9362* (A).

CHINA: YUNNAN: Kengma, *Yu 17294* (A); Liukiang, Muchietu, *Yu 21012* (A); Makwan Hsien, *Tsai 51945* (A); Mar-li-po, Sze-tai-po, *Feng 13765* (A); Mienning, *Yu 17952* (A); Ping-pien Hsien, *Tsai 55421, 60261, 60499, 62396* (A); Shang-pa Hsien, *Tsai 54799* (A); without precise locality, *Forrest 17496* (A).

INDO-CHINA: Chapa, Tonkin, *Pételot 5936* (A, NY).

The particularly dense pubescence on both surfaces of the leaf makes *Celastrus hirsutus* easily recognized and distinguished from other species of the genus. On the other hand, as Comber previously has pointed out, its floral characters are quite similar to *Celastrus kusanoi* Hay. Specimens of these two entities indicate that although their floral characters are similar, their geographical distributions and

leaf and lenticel characters are distinct. For these reasons I am considering them as two separate species.

22. CELASTRUS STYLOSUS Wall. in Roxb. Fl. Ind. ed. Carey 2:401. 1824; Wall. Cat. 4313. 1831; Lawson, in Hook. Fl. Brit. Ind. 1:618. 1875 (pro parte); Prain, in Jour. Asiat. Soc. Bengal 73:198. 1904. (T.: *Wallich 4313*, MO, photo!).

Scandent shrubs, 3–4 m. tall; branches terete, glabrous or puberulent on the branchlets, light brown to dark brown, sparsely lenticelled, the lenticels small, elliptic or ovate; axillary buds globose or ovoid, about 2 mm. long. Leaves usually elliptic-oblong, ovate to obovate, the apex acute, the base acute or obtuse, the margins serrate, 6–15 cm. long, 3–9 cm. wide, membranous to firmly membranous, glabrous or rarely pubescent on the veins below, the primary lateral veins usually 5–7 pairs, distinctly elevated below, plane or slightly elevated above, the veinlets prominent below, obscure to visible above; stipules filiform, about 1 mm. long; petioles usually 1–2 cm. long. Inflorescences axillary and cauline, usually 3- to 7-flowered, at the basal part of the current year's growth (rarely also terminal in the male plant of *Celastrus stylosus* ssp. *stylosus*), distinctly pedunculate; the peduncles puberulous to glabrous, the primary peduncles 5–11 mm. long; flowers dioecious, green or pale green, the pedicels 2–5 mm. long, the articulation toward the base of the stalk. Male flowers: calyx lobes imbricate, oval to oblong, obtuse, slightly erose to entire, about 1.5 mm. long; petals obovate, obtuse, slightly erose, about 2–4 mm. long and 1.0–1.5 mm. wide; stamens arising between the disc-lobes, about 2.5 mm. long, the filaments filiform, fleshy, glabrous to papillose-tuberculate, the anthers ovoid, cordate; disc membranous, cup-shaped, the lobes distinctly arcuate or depressed-quadrate; sterile pistil about 1.5 mm. long. Female flowers: calyx lobes, petals, and disc as in the male; sterile stamens about 1 mm. long; pistil flask-shaped, about 3 mm. long, the ovary subglobose, the style distinctly columnar, the stigmata 3-lobed, each lobe bifid, flat, reflexed. Fruits subglobose, the valves broadly elliptic, about 7–12 mm. long and 5–10 mm. wide, 3- to 6-seeded; seeds more or less plano-convex to slightly lunate, attenuate at both ends, reddish- to blackish-brown, about 4–6 mm. long and 1–2 mm. wide, the areolae distinct.

KEY TO THE SUBSPECIES

A. Staminal filaments always densely papillose-tuberculate; the disc-lobes depressed-quadrate; leaves elliptic, membranous. India ..... 22a. ssp. *stylosus*
AA. Staminal filaments usually glabrous, rarely sparsely papillose-tuberculate; the disc-lobes arcuate; leaves usually elliptic-oblong, firmly membranous. China..... 22b. ssp. *glaber*

22a. CELASTRUS STYLOSUS ssp. STYLOSUS.

Celastrus neglecta Wall. Cat. 4341. 1831, nom. nud.
Gymnosporia neglecta Wall. ex Lawson, in Hook. Fl. Brit. Ind. 1:619. 1875; Prain, in Jour. Asiatic Soc. Bengal 73:198. 1904, Novic. Ind. 419. 1905. (based on *Celastrus neglecta* Wall., *Wallich 4341*).

In thickets, at altitudes from 1,000 to 2,745 m.; India; flowering from March to July.

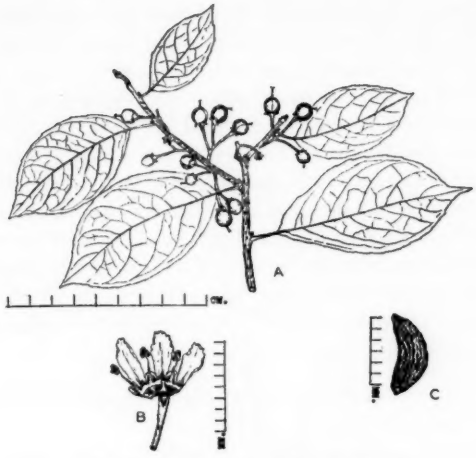


Fig. 12. *Celastrus stylosus* ssp. *stylosus*

INDIA: ASSAM: Khasi, *Kurz 171* (CAL), *Clarke 18678*[C] (CAL). BENGAL: Darjeeling, *Boswastore 73* (CAL), *Clarke 26701*[B] (CAL), *Kurz s. n.* (CAL). SIKKIM: Duphla Hills, *Lister 157* (CAL); Lachen, *Smith & Cave 964* (CAL); Moughoo, *Lister s. n.*, March 1878 (CAL); Punkabari, *Lister s. n.*, April 1878 (CAL); Singolila forest, *Rogers s. n.*, Jan. 1900 (CAL); Sureil, *Dr. Prain's collector 439* (CAL). WITHOUT PRECISE LOCALITY: *Anderson 104* (CAL); *Meebold 15912* (S).

22b. CELASTRUS STYLOSUS ssp. **glaber** Ding Hou, stat. et nom. nov.

Celastrus hypoleucus forma γ. *puberula* Loes. in Engl. Bot. Jahrb. 29:445. 1900. (T.: *Rosthorn 1556*[b], A, photo!).

Celastrus crassifolia Wang, in Chin. Jour. Bot. 1:62. 1936; in Contr. Bot. Surv. N. W. China 1:62. 1939. (T.: *Yu 445*, A!).

Chiefly in thickets, at altitudes from 800 to 2,000 m.; China and Indo-China; flowering in April.

CHINA: ANHWEI: Kimen, *Ip 41* (UC); *Ching 3165* (UC); Wong Shan, *Ling 1104* (UC). KWANGSI: Chuen Yuan, *Tsoong 82041* (A); Kwei-lin Hsien, *Tsang 38365* (US); Ling-yuin Hsien, *Steward & Cheo 87* (A, NY, S, SING), *396* (NY, S); Nanning, Seh-feng-dar Shan, *Ching 8205* (NY, UC, US); Shang-sze Hsien, *Tsang 24131* (A, MO); Pin-lam, *Ko 55544* (A); Tsin-hung Shan, Hin Yen, *Ching 7080* (A, US). KWEICHOW: Mapo, Pingchow, *Tsiang 6832* (A, NY). SIKANG: Tien-chuan Hsien, *Tai & Feng 5238* (A). SZECHUAN: Nan-chuan, *v. Rosthorn 1556*[b] (A, photo of type of *C. hypoleuca* forma γ. *puberula*); Omei Shan, *Fang 15211, 15280* (A), *Lee 3168* (A), *Yu-shih Liu 1184* (A), *Yu 445* (A, type of *C. crassifolia*); Wa-shan, *Wilson 1184* (A); without precise locality, *Henry 5559* (A, GH). YUNNAN: Chungtien, *Feng 3365* (A); Hokin, *Feng 747* (A); Lung-ling Hsien, *Tsai 54563, 54578* (A); Mar-li-po, Chung-dzia, *Feng 12727* (A); Mengtze, *Henry 10522, 11267* (A, MO); Ping-pien Hsien, *Tsai 60420, 60919, 61156, 61629* (A); Shang-pa Hsien, *Tsai 54929* (A); Shunning, Wumulung, *Yu 16592* (A); Si-chour Hsien, *Feng 12260, 12283* (A); without precise locality, *Forrest 9396, 15980* (A), *Li 1181* (A), *Tsai 62841* (A).

INDO-CHINA: Chapa, Tonkin, *Pételot 5829, 5946* (A, NY, US).

These two subspecies are superficially similar except for the staminal filaments, the leaf shapes, and the geographical distributions as shown in the key.

Subspecies *glaber* is widely distributed in China; its extra-axillary inflorescences and firmly membranous elliptic-oblong leaves make it easy to separate from other related species. The staminal filaments are usually glabrous; however, a few specimens collected from Kwangsi and Yunnan are slightly papillose-tuberculate. Because of the intermediate leaf forms, staminal filaments, and distinctly geographical distributions, I consider the Chinese population as a subspecies of *C. stylosus*.

Under the provisions of the International Rules, priority of publication operates only within individual taxa. It would therefore be rather inappropriate to employ Loesener's epithet "puberula" in this instance, since Loesener chose the epithet with reference to the puberulence of the leaves of *Rosthorn 1556*[b], which actually is an abnormal condition for the other known specimens of *Celastrus stylosus* ssp. *glaber*. Thus, I have chosen the epithet "glaber" with reference to the more significant character of the staminal filaments.

23. CELASTRUS ACULEATUS Merr. in Lingn. Sci. Jour. 13:37. 1934. (T.: *Tsang 20092*, NY!).

Celastrus hookeri sensu Rehd. & Wils. in Sarg. Pl. Wils. 2:352. 1915, as to specimens cited, in part, non Prain.

Celastrus oblanceifolia Wang & Tsoong, in Chin. Jour. Bot. 1:65. 1936, ex char. (T.: *Tsoong 2443*).

Scandent shrubs up to 10 m. tall; branches terete, glabrous, the young branchlets sometimes brownish-pubescent, brownish-red to dark brown, both branches and branchlets lenticellate, the lenticels orbicular, sparse to dense. Axillary buds ovoid, about 2.5 mm. long, the outermost scales persistent, usually deltoid and spiny, acute to acuminate, accrescent, up to 5 mm. long. Leaves elliptic to oblanceolate, the apex acute, the base cuneate to obtuse, the margins remotely serrulate, 3–10 cm. long, 1.5–6.0 cm. wide, membranous, usually glabrous, rarely pubescent on the veins below, the primary lateral veins 4–5 pairs, arcuate toward the apex, immersed, distinct to slightly elevated below, obscure above, the veinlets usually obsolete on both surfaces; stipules laciniate, filiform, about 1 mm. long; petioles 7–12 mm. long. Inflorescences axillary and cauline at the lower part of the flowering branch, shortly pedunculate, the primary peduncles almost obsolete to 3 mm. long, usually 3-flowered, puberulous; flowers dioecious, greenish-yellow, subsessile, the articulation just below the flower. Male flowers: calyx lobes imbricate, ovate-deltoid to oblong, obtuse, entire, subglabrous without, accrescent, about 1.0–1.5 mm. long; petals oblong to oblanceolate, obtuse, slightly undulate, puberulent at the basal parts on both surfaces, about 3.5–4.5 mm. long and 1 mm. wide; disc fleshy, annular, entire; stamens arising from the margin of the disc proper, about 3 mm. long, the filaments filiform, densely papillose-tuberculate; sterile pistil ovoid, about 2 mm. long. Female flowers: calyx, petals, and disc as in the male; sterile stamens 1.5 mm. long, papillose; pistil subglobose, the style columnar, distinct, the stigmata discoid or slightly 3-lobed. Fruits subglobose, the valves broadly elliptic, about 8 mm. long and 7 mm. wide, 3- to 6-seeded; seeds

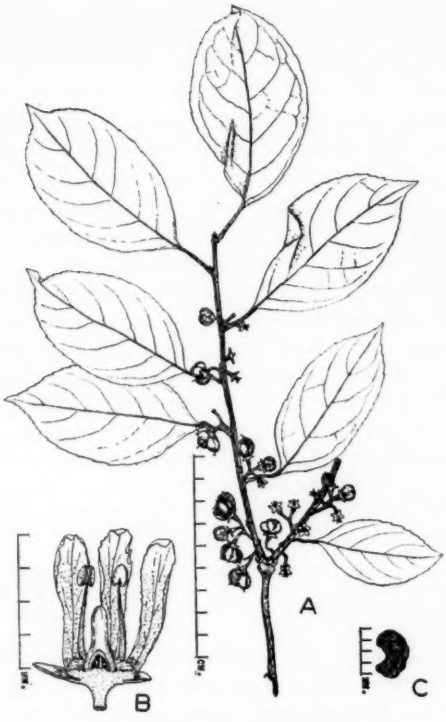


Fig. 13. *Celastrus aculeatus* Merr.

arcuate or semi-annular, about 4.5 mm. long and 1.5 mm. wide, brown, slightly wrinkled, distinctly areolate.

In open fields or in thickets, from lowland up to about 900 m. elevation; southeastern China; flowering from March to April.

CHINA: CHEKIANG: Sia-chu, *Ching 1664* (A, US); Taichow, *Ching 1336* (US); Tsi-shun, *Keng 285* (A); Tsingtien Hsien, *Keng 73* (A). FUKIEN: Amoy, *Chung 1514* (A, UC), *1693* (A, SING, US), *1773* (US), *4774* (A), *4777* (A), *5954*, *6235* (A); Baekliang and vicinity, *Siu-Ging Tang 15609* (UC); Chuanchow, *Chung 3085* (UC); Diongloh and vicinity, *Ku Tai Lin 11677* (UC); Foochow, *Norton 1346* (UC), *Chung-Chang Tang & Shan En Ma 2936* (US); Kuliang, *Chung 7264* (A, F); Kushan and vicinity, *Cheng 1573* (UC); Kutien, *Chung 4036* (A); Minhow Hsien, *Chung 2065* (UC); Pucheng, *Ching 2508* (A, UC, US); Tsze-chook-Hang, central Fukien, *Dunn s. n.* (HK, A); Yenping, *Kuang-Han Chou 8215*, *8460* (UC); Yuen-fu gorges, *Dunn s. n.* (HK, A). HUNAN: Yi-chang Hsien, *Tsang 23574* (A, US). KIANGSI: Kaoan, *Tsiang 10460* (NY); Kiennan Hsien, *Lau 4367* (A, S, US); Lungnan Hsien, *Lau 4801* (A, S, US); Lu Shan, *Chiao 18768* (US); Swe-chuen, *Hu 889* (A); Yung-shing, *Hu 784* (A); without precise locality, *Hu s. n.*, 1920 (UC). KWANGTUNG: Ho-yuen, *Tsang 28843* (A); Kowloon, *Wang 3060* (NY, SING); Mt. Lung-t'au, near Iu, *Kang-peng To et al 631* (US); Lungtung, *Tso 21640* (NY); Mei Hsien, *Tsang 21416* (A, NY, S); Mui-nen Hsien, *McClure & Shang 4* (UC); Naam-kwan-shan, Lung-men, *Tsang 25268* (A); Sin-fung Hsien, *Taam*

724, 1041 (A); Kakchieh, Swatow, *Gressitt 1767* (MO); Ta-ching, *Chun 5539* (A); Tapu, *Tsang 21189* (A, NY, S); Tsengshing Hsien, *Tsang 20092* (NY, holotype of *C. aculeatus*; A, isotype); Wai-yeung, *Tsui 154* (A, MO, NY, UC, US); Yao-shan, *Sin 11889* (NY).

This species is well characterized by the arcuate seeds, the papillose-tuberculate filaments, the fleshy and annular disc, and the obsolete veinlets of the leaves. *Celastrus aculeatus* is a very distinctive species of southeastern China. Most of the specimens which are cited here have been identified as *Celastrus hookeri* Prain. *Celastrus hookeri*, however, is easy to separate from *Celastrus aculeatus* by its glabrous filaments, its cup-shaped disc, and its ovoid seeds.

A specimen collected by Ching *(2508)* from northern Fukien has puberulent veins and slightly oblanceolate leaves. It matches the description of *Celastrus oblanceifolia* Wang & Tsoong from southern Anhwei which also has oblanceolate leaves. The veinlets described for *Celastrus oblanceifolia* are reported to be obsolete here and the seeds are said to be curved, both typical characters of *Celastrus aculeatus*. Because of these morphological similarities and the identical geographical distribution, *Celastrus oblanceifolia* is placed in synonymy.

24. CELASTRUS FLAGELLARIS Rupr. in Bull. Acad. Sci. St. Pétersb. II, 15:357. 1857, ex char.

Celastrus ciliidens Miq. in Ann. Mus. Bot. Lugd.-Bat. 2:85. 1865–66, ex char.
Celastrus clemacanthus Lévl., in Fedde, Rep. Spec. Nov. 8:284. 1910. (T.: *Taquet 632*, A!).

Scandent shrubs; branches and branchlets terete to slightly striate, glabrous, brown to dark brown, the lenticels small, oval, sparse, the young branchlets clinging by a line of filiform, branched aerial roots; axillary buds small, depressed-ovoid, usually protected by two prominent, broadly falcate, spiny scales, acuminate, about 3 mm. long. Leaves broadly elliptic to suborbicular, the apex obtuse to shortly acuminate, the base cuneate to obtuse, the margins finely ciliate-serrate, 3.0–5.5 cm. long, 2–5 cm. wide, delicately membranous, glabrous or puberulous on the veins below, the primary lateral veins 4–6 pairs, distinctly elevated below, slightly elevated above, the veinlets distinct, sometimes elevated below, obscure above; stipules laciniate, filiform, about 5 mm. long; petioles 1.5–2.5 cm. long. Inflorescences axillary, solitary or fascicled, or clustered on the short young branchlets, the peduncles about 2–5 mm. long; flowers dioecious, white or yellowish-green, the pedicels 1–4 mm. long, the location of articulation varying from the lower to upper half of the stalk. Male flowers: calyx lobes imbricate, oblong, obtuse, ciliate, about 2 mm. long; petals obovate-oblong to elliptic-oblong, ciliate to slightly erose, about 4 mm. long and 1.3 mm. wide; disc cup-shaped, the lobes inconspicuous; stamens arising from the margin of the disc, about 4 mm. long, the filaments fleshy, filiform, glabrous, the anthers ovoid, obtuse, apiculate, cordate; sterile pistil columnar, about 1 mm. long. Female flowers: calyx lobes, petals, and disc as in the male but smaller; sterile stamens about 0.5 mm. long, subsessile, triangular-cordate; pistil about 2.8 mm. long, the ovary subglobose, the style

columnar, distinct, the stigmata trilobed, each lobe deeply bifid, reflexed. Fruits globose, the valves broadly elliptic to suborbicular, 6–7 mm. long and 5–7 mm. wide, 3- to 6-seeded; seeds shortly ellipsoid, about 3.5 mm. long and 2 mm. wide, brown, the areolae obscure.

Lowland thickets, at altitudes up to 1,000 m.; China, Korea, and Japan; flowering from May to August.

CHINA: CHEKIANG: Yu-tsien, *Hu 1631* (A, UC). NORTHEASTERN CHINA: ad fl. Amur, *Maack s. n.*, 1855 (GH); sinus Possict, *Maximowicz s. n.*, 1860 (GH).

KOREA: Chulla, *Mrs. R. K. Smith s. n.* (A); Gyouhfeng, *Taquet 2723* (A); Quelpaert, scandens in muris agrorum Haouen, *Taquet 632* (A, type of *Celastrus clemacanthus*); Hongo-san, Prov. Hogen, *Wilson 10425* (A); Ping Yang, *Jack s. n.*, Sept. 18, 1908 (A); Puk Han, Seoul, *Jack s. n.*, Sept. 25, 1905 (A); Nam-san, Seoul (Heijyo), Prov. Heiki, *Wilson 8450* (A, US).

JAPAN: Kawagishi, Naganoken, *Uno 21823* (A, NY); Musatre, Mitake, *Hayakawa s. n.*, May 20, 1910 (S); Thinano, Suwa, *Sakurai s. n.*, May 21, 1913 (A); Thinano, Nagano, *Sakurai s. n.*, June 19, 1913 (A); near Lake Yamanaka, *Dorsett & Morse 619* (A, US).

This species is easily recognized by its characteristic ciliate-serrate leaves and the two persistent spiny outermost bud scales. Its branches sometimes produce aerial roots which function as attachment organs on smooth surfaces. The flowers are usually clustered on young shoots which occasionally elongate during the fruiting stage.

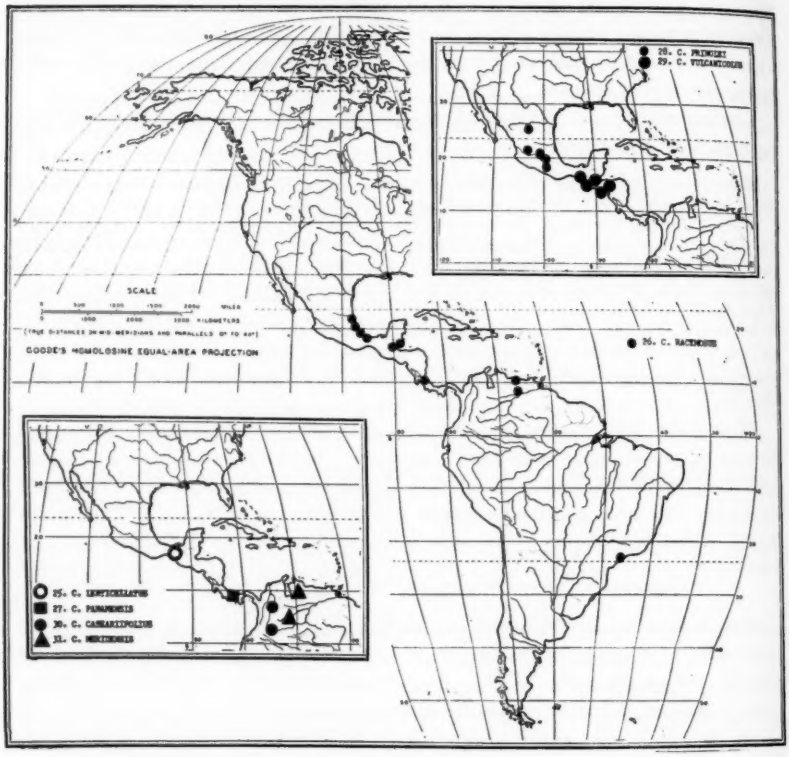
Subgenus II. RACEMOCELASTRUS Ding Hou, subgen. nov.

Frutices scandentes. Flores hermaphroditi; ovario triloculare, in quoque loculo ovulo singulo. Capsula semine singulo, ovulis manifeste abortivis binis. America centralis et australis.

Type species: *Celastrus racemosus* (Reiss.) Loes.

KEY TO THE SPECIES

A. Inflorescences paniculiform, obviously compound.
  B. Inflorescences thrice- or multi-compound, up to 14 cm. long; lenticels dense. Mexico: Chiapas ..... 25. *C. lenticellatus*
  BB. Inflorescences usually once or twice compound, up to 6 cm. long; lenticels scattered.
    C. Inflorescences usually clustered in the leaf axils; peduncles not associated with vegetative buds; leaves elliptic. Brazil, Venezuela, Costa Rica, British Honduras, Guatemala, El Salvador, and Veracruz, Mexico ..... 26. *C. racemosus*
    CC. Inflorescences solitary in the leaf axils; peduncles associated with vegetative buds; leaves ovate. Panama ..... 27. *C. panamensis*
AA. Inflorescences racemiform, obscurely compound.
  D. Pedicels of the flowers 1–2 mm. long.
    E. Anthers distinctly apiculate; fruit valves about 12–14 mm. long, the septa 1.0–2.5 mm. wide; leaves closely serrate. Central Mexico ..... 28. *C. pringlei*
    EE. Anthers obscurely apiculate; fruit valves about 14–18 mm. long, the septa 4.0–6.0 mm. wide; leaves remotely serrate to entire. Chiapas, Mexico; Guatemala; Honduras; El Salvador ..... 29. *C. vulcanicolus*
  DD. Pedicels of the flowers obsolete or less than 1 mm. long.
    F. Leaves oblanceolate-oblong; lenticels large, dense and elevated; anthers apiculate. Colombia ..... 30. *C. caseariifolius*
    FF. Leaves broadly elliptic or ovate; lenticels small, sparse and obscure; anthers not apiculate. Colombia and Venezuela ..... 31. *C. meridensis*



Map 4. Distribution of seven species of *Celastrus* Subgenus RACEMOCELASTRUS.

25. CELASTRUS LENTICELLATUS Lundell, in Bull. Torr. Bot. Club 67:616. 1940. (T.: *Purpus 7370*, US!).

Scandent shrubs; branches glabrous, black-brown, the lenticels small, dense, white, slightly elevated; axillary buds conoid, acute, about 2 mm. long. Leaves broadly elliptic, the apex abruptly short-acuminate, the base cuneate to rotund, the margins remotely serrulate, 10–20 cm. long, 5.0–7.8 cm. wide, chartaceous, glabrous, the primary lateral veins distinctly elevated below, plane or slightly impressed above, the veinlets prominent below, obscure to visible above. Stipules filiform, about 1 mm. long; petioles rather stout, 6–12 mm. long. Inflorescences axillary as well as terminal, solitary or fasciculate, thrice or multicompound, paniculiform, up to 14 cm. long, much branched at the base, the peduncles glabrous, the primary peduncles 1–5 mm. long; flowers bisexual, the pedicels about 1 mm. long, the articulation at the lower part of the stalk. Calyx lobes valvate, ovate, rotund, minutely erose, 0.5–0.8 mm. long; petals oblong, rotund, entire, brown-punctate, 1.8 mm. long and 1 mm. wide; disc fleshy, flat, about 1.5 mm. in

diameter, the lobes depressed-rectangular; stamens attached slightly under the margin of the disc, about 2 mm. long, the filaments filiform, glabrous, the anthers ovoid, obtuse, slightly apiculate; pistil short, ovoid, about 1 mm. long, the style stout, the stigmata obscure. Fruit unknown.

Mexico: Chiapas; flowering in June.

MEXICO: Chiapas, Finca San Cristobal, *Purpus 7370* (F, type; MICH; US, holotype).

The paniculiform inflorescences and the densely lenticellate branches make this species easily separated from other Latin American *Celastrus* species.

26. CELASTRUS RACEMOSUS (Reiss.) Loes. in Engl. Bot. Jahrb. 24:199. 1898, (as *racemosa*).

Maytenus racemosus Reiss. in Mart. Fl. Bras. 11:30, *pl. 4, f. 15.* 1861. (T.: *Riedel s. n.*, US!).
Celastrus liebmannii Standl. in Publ. Field Mus. Bot. 8:316. 1931. (T.: *Liebmann 14871*, MO!).
Celastrus pachyrachis Lundell, in Lilloa 4:382. 1939. (T.: *Jahn 476*, US!).
Celastrus mainsiana Lundell, in Lloydia 2:99. 1939. (T.: *Lundell 6307*, MICH!).

Scandent shrubs up to 50 m. tall; branches terete, glabrous, blackish-brown, the lenticels scattered to dense, white, elliptic to orbicular; axillary buds conoid, acute, about 1 mm. long. Leaves elliptic to ovate, the apex acute, the base cuneate to rotund, the margins crenulate-serrulate, 5–12 cm. long, 3–5 cm. wide, firmly membranous, glabrous, the primary lateral veins 7–9 pairs, slightly elevated below, plane and visible above; stipules subulate, erose, about 1 mm. long; petioles 3–10 mm. long. Inflorescences axillary, 1- to 3-branched, once compound, up to 4 cm. long, the primary peduncle glabrous, about 3 mm. long; flowers bisexual, greenish-white, the pedicels 2–3 mm. long, accrescent, the articulation toward the base of the stalk. Calyx lobes imbricate, deltoid, obtuse, subentire, brownish-punctate, about 1 mm. long; petals oblong, obtuse, subentire, about 1.5 mm. long and 1 mm. wide; disc fleshy, flat, about 1.5 mm. in diameter, the lobes subreniform; stamens attached slightly beneath the disc margin, about 1.5 mm. long, the filaments linear, glabrous, the anthers ovoid, obtuse, rarely apiculate; pistil ovoid, about 1 mm. long, the style columnar and blunt. Fruits ellipsoid, the pedicels 2.5–5.0 mm. long, the valves broadly elliptic, 14–21 mm. long and 8–11 mm. wide, the septa 2.5–6.0 mm. wide, 1-seeded; seeds cylindric, about 10–13 mm. long and 7–9 mm. wide, pinkish-brown, areolae obscure.

In wet forests or thickets, at altitudes 1,400–2,400 m.; Mexico, British Honduras, Guatemala, Costa Rica, Venezuela, and Brazil; flowering from March to August.

BRAZIL: Rio de Janeiro, *Riedel s. n.* (US, type of *Maytenus racemosus*).
BRITISH HONDURAS: El Cayo Dist., *Lundell 6307* (MICH, holotype of *C. mainsiana*).
COSTA RICA: Heredia, *Standley & Valerio 52024* (US).
GUATEMALA: Tactic, *Standley 71349* (F).
MEXICO: VERA CRUZ: near Jalapa, *Pringle 8133* (K, MO, NY, S, UC, US); Mirador, *Liebmann 14871* (F, type of *C. liebmannii*; MO), *14872, 14873, 14874, 14875*[a], *14875*[b] (F), *14875* (GH, UC, US), *Purpus 8926* (MO, NY, UC, US); Zacuapan, *Purpus 7094* (F, MO, NY, UC), *8080* (MO, NY, UC, US).

VENEZUELA: east of El Junquito, *Steyermark 57015* (F, NY, US); Macarao, *Jahn 476* (US, holotype of *C. pachyrachis*).

This is a widely and disjunctively distributed species of the Latin American *Celastrus*. It is found in the rain forests or thickets from Vera Cruz, Mexico, southward to Rio de Janeiro, Brazil.

Lundell[41] has stated, "from examination of the type photograph of *C. racemosus* (Reiss.) Loes., the similarity of that species and the type of *C. liebmannii* is striking." I have seen the types of *Celastrus racemosus* and *C. liebmannii*; in addition, I have examined specimens collected from Vera Cruz, British Honduras, Guatemala, Costa Rica, and Venezuela. They are all similar and excessively difficult to separate into two species.

This species is closely related to *Celastrus pringlei* Rose and *C. vulcanicolus* Donn. It can be distinguished from them by the distinctly once compound, aggregate dichasia and longer pedicels. The other two species bear racemiform inflorescences and have very short pedicels.

27. CELASTRUS PANAMENSIS Lundell, in Contr. Univ. Mich. Herb. 6:40. 1941. (T.: *Allen 319*, MO!).

Scandent shrubs; branches terete, glabrous, smooth, shining, reddish-brown, the lenticels small, obscure, elliptic; axillary buds conoid, acute, about 1 mm. long. Leaves ovate, the apex obtuse, the base rotund, the margins shallowly crenate, 9–14 cm. long, 5.0–7.5 cm. wide, membranous, glabrous, the primary lateral veins 7–8 pairs, elevated below, plane and distinct above, the veinlets slightly elevated below, plane and visible above; stipules deltoid, erose, about 1 mm. long; petioles 11–13 mm. long. Inflorescences axillary as well as terminal, up to 6 cm. long, usually twice compound, the primary peduncles glabrous, about 1.2–2.5 cm. long, associated with a vegetative bud in the axil; flowers bisexual, white, the pedicels about 1 mm. long, the articulation toward the base of the stalk. Calyx lobes imbricate, obtuse, minutely erose, about 1.2 mm. long, brownish-punctate; petals oblong, rotund, more or less entire, about 2 mm. long and 1.2 mm. wide; disc fleshy, flat, about 2 mm. in diameter, the lobes subreniform; stamens attached slightly beneath the margin of the disc, about 2 mm. long, the filaments filiform, glabrous, the anthers ovoid, slightly apiculate; pistil short, conoid, about 1.5 mm. long, the style columnar and blunt. Fruit unknown.

At altitudes 1,400–2,300 m.; Panama; flowering in April.

PANAMA: CHIRIQUI: *Allen 319* (MO, type; P).

The floriferous branch of this species is very characteristic and different from other Latin American *Celastrus* species in having the peduncle with an associated axillary vegetative bud. I have seen only the type collection. It is a young flowering branch.

[41] In Lilloa 4:380. 1939.

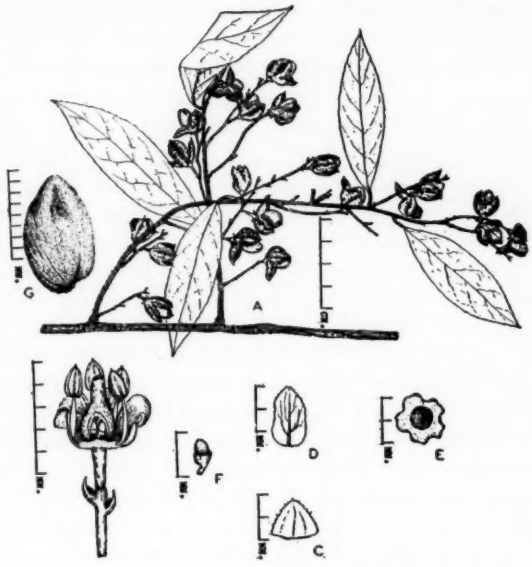


Fig. 14. *Celastrus Pringlei* Rose

28. CELASTRUS PRINGLEI Rose, in Contr. U. S. Nat. Herb. 5:195. 1899. (T.: *Pringle 6842*, MO!).

Celastrus longipes Lundell, in Lilloa 4:381. 1939. (T.: *Palmer 106*, MO!).

Scandent shrubs up to 5 m. high; branches terete, glabrous, brown or reddish-brown, densely lenticelled, the lenticels elliptic or ovate, slightly elevated, white; axillary buds suborbicular, about 1 mm. long. Leaves narrowly elliptic, the apex acute to acuminate, the base attenuate, the margins serrulate, 6–10 cm. long, 2–4 cm. wide, membranous, glabrous, the primary lateral veins 7 pairs, elevated below, plane and distinct above, the veinlets slightly elevated beneath, visible above; stipules filiform, tufted, about 1 mm. long; petioles 5–12 mm. long. Inflorescences axillary, 1- to 4-branched, racemiform, usually 2.0–3.5 cm. long, the primary peduncles glabrous, obscure to about 5 mm. long, the secondary peduncles about 3–8 mm. long, with 2–3 prophylls; flowers bisexual, white, the pedicels about 1.2 mm. long, the articulation usually at the upper half of the stalk. Calyx lobes imbricate, ovate, marginate, scarious and slightly ciliate, about 1.5 mm. long; petals obovate, rotund, slightly erose, 2.5 mm. long and 1.2 mm. wide; disc fleshy, flat, the lobes depressed-subquadrate; stamens attached just beneath the disc margin, about 2.5 mm. long, the filaments linear, glabrous, the anthers suborbicular, apiculate; pistil flask-shaped, about 2 mm. long, the ovary ovoid, the style cylindric and blunt. Fruits ovoid, the valves 12–14 mm. long and 7.5–9.5 mm. wide, the

septa 1.0–2.5 mm. wide, 1-seeded; seeds broadly ellipsoid, 10–12 mm. long and 7 mm. wide, pinkish-brown, shining, the areolae distinct.

In forests, at altitudes 790–2,300 m.; Mexico; flowering from March to June.

MEXICO: canyons of mountains above Cuernavaca, *Pringle 6842* (MO, type of *C. pringlei;* GH, L, S, UC); Temascaltepec, *Hinton 290* (F), *3506* (GH, US), *3574* (NY, US), *3717, 6076, 7203* (GH, US), *7380* (US), *9020* (GH, US). DURANGO: San Ramón, *Palmer 106* (MO, type of *C. longipes;* US). JALISCO: *McVaugh 10246, 10308, 13906* (MICH). MICHOACAN: Tancitaro, *Leavenworth & Hoogstraal 1023* (F, GH, MICH, MO, NY). MORELOS: Sierra de Tepoxtlan, *Pringle 6998* (GH, MICH, MO, NY, S, UC).

The type specimen of *Celastrus longipes* seems to have larger leaves and longer peduncles than the type of *C. pringlei.* These characters are variable in all the specimens I have examined, and I think that they might be due to the differences in altitude. I have found some floriferous branches which are subtended by foliage leaves. This subtending foliage leaf may be from the previous year's growth. For example, a specimen *(McVaugh 10308)*, collected at altitudes 2,400–2,600 m. in Jalisco, Mexico, on April 14, has a main branch bearing three floriferous branches. Each of the branches is subtended by a foliage leaf. When I made a cross-section of the main branch two porous rings of spring wood showed clearly. From this I assumed it might be an evergreen species, but, Dr. McVaugh told me he has collected another specimen in fruit with all of the leaves fallen off.

29. CELASTRUS VULCANICOLUS Donn. Smith, in Bot. Gaz. 61:373. 1916. (T.: *Donn. Smith 2549,* US!).

Celastrus chiapensis Lundell, in Lilloa 4:380. 1939. (T.: *Matuda 2080,* MICH!).
Celastrus siltepecanus Lundell, in Wrightia 1:155. 1946. (T.: *Matuda 5192,* MO!).
Maytenus williamsii A. Molina R., in Ceiba 1:258. 1951. (T.: *Merrill et al 15640,* F!).

Scandent shrubs up to 7 m. tall; branches terete, glabrous, gray to reddish-brown, the lenticels obscure on the gray branches while distinct on the reddish-brown ones, orbicular or ovate; axillary buds globose, about 1 mm. in diameter. Leaves elliptic, the apex acuminate or acute, the base cuneate or obtuse, the margins entire, repand, or slightly serrulate, 6–12 cm. long, 2.5–5.0 cm. wide, firmly membranous, glabrous, the primary lateral veins 7–9 pairs, curved toward the apex, elevated below, plane and distinct above, the veinlets slightly elevated below, obscure to visible above; stipules filiform, about 1 mm. long; petioles 4–12 mm. long. Inflorescences axillary, racemiform, 1- to 5-branched, up to 3.5 cm. long, few-flowered, the primary peduncles glabrous, obsolete to about 5 mm. long, the secondary peduncles about 3 mm. long, usually with 2 prophylls; flowers bisexual, pale green, the pedicels about 2 mm. long, the articulation usually at the middle or lower half of the stalk. Calyx lobes ovate or deltoid, thick, obtuse, marginate, scarious, slightly erose, about 1 mm. long; petals oblong-elliptic, obtuse, minutely erose, about 2.0–2.5 mm. long and 1 mm. wide; disc fleshy, flat, about 2 mm. in diameter, the lobes depressed-rectangular; stamens attached beneath the disc margin, about 2 mm. long, the filaments filiform, glabrous, the anthers subglobose, slightly apiculate; pistil 1.5 mm. long, the style slender and blunt. Fruits ellipsoid, the valves broadly elliptic, about 14–18 mm. long and 7–10 mm. wide, 1-seeded;

seeds ellipsoid, 12–14 mm. long and 6–9 mm. wide, reddish-brown, shining, the areolae obscure.

In forests, at altitudes 1,300–2,400 m.; Mexico, Guatemala, Honduras, and El Salvador; flowering from December to January.

EL SALVADOR: Santa Ana, north of Metapán, *Carlson 900* (F).

HONDURAS: Dept. Morazan, *Merrill et al. 15640* (F, type of *Maytenus williamsii*; US); San Juancito, *Williams & Molina R. 17100* (F).

GUATEMALA: Dept. Alta Verapaz, *Standley 71349* (F); Dept. Chiquimula, *Steyermark 31480* (F); Dept. Quezaltenango, *Steyermark 33635, 33692, 33775* (F), *Standley 65402* (F), *65411, 86972* (F, MICH); Dept. Sacatepequez, *Standley 63667* (F), *Donn. Smith 2549* (US, type of *C. vulcanicolus*).

MEXICO: CHIAPAS: Fraylesca, Siltepec, *Matuda 5192* (MO, type of *C. siltepecanus*); Cascada, Siltepec, *Matuda 5148* (F); Mt. Ovando, *Matuda 2080* (MICH, holotype of *C. chiapensis*), *3944* (F, MICH, MO, NY, US), *16396* (UC). HIDALGO: Molango, *Moore 2698* (GH). OAXACA: Cumbre de Talea, *Reko 4019* (US).

This species is closely related to *Celastrus pringlei* Rose, but can be distinguished from it by the entire or remotely serrulate leaf margins, the obscure connectives, the larger fruits with wider septa, and especially the geographical distribution.

The type specimens of *Celastrus siltepecanus* Lundell is similar to the present species except for the distinct and slightly elevated veins on both surfaces of the leaves, and the small distinct lenticels borne on the branches. These characters might be caused by the environment and are within the range of variation of the species.

The specimens assigned to *Maytenus williamsii* A. Molina R. are *Celastrus* and are congruent with the present species. The leaves and fruits are smaller, which might be due to the high altitude of the habitat.

30. CELASTRUS CASEARIIFOLIUS Lundell, in Lilloa 4:379. 1939. (T.: *Lehmann s. n.*, F!).

Branchlets terete, glabrous, reddish-brown, densely lenticellate, the lenticels oval, elevated; axillary buds conoid, about 1.5 mm. long. Leaves oblanceolate-oblong or elliptic-oblong, the apex acute to shortly acuminate, the base obtuse, the margins remotely serrulate, 4.5–10.5 cm. long, 1.4–4.0 cm. wide, chartaceous, glabrous, the primary lateral veins 7–9 pairs, veins and veinlets slightly elevated below, obscure above; petioles 3–5 mm. long. Inflorescences axillary, racemiform, 1- or 2-branched, up to 2.5 cm. long, the primary peduncles obscure, the secondary peduncles about 1.5 mm. long. Flowers (young) bisexual, the pedicels obsolete to about 0.8 mm. long, the articulation at the upper half of the stalk. Calyx lobes imbricate, ovate or ovate-deltoid, erose-ciliolate; petals ovate-oblong, obtuse, subentire; disc fleshy, flat, the lobes obscure, the stamens arising from the margin of the disc, the filaments glabrous, the anthers suborbicular, apiculate; pistil ovoid, the style short and columnar, the stigmata obscure. Fruits cylindric, the valves oblong, about 16 mm. long and 7 mm. wide, 1-seeded; seeds cylindric, obtuse at both ends, 15 mm. long and 6 mm. wide, black and smooth.

In the forests of highlands, at altitudes 1,600–2,000 m.; Colombia; flowering from May to June.

COLOMBIA: Dept. de Antioquia, *Daniel 3295* (F); highlands of Popayan, *Lehmann s. n.*, 1,600–2,000 m. elev., May 1889 (F, holotype), *399* (L, NY).

Celastrus cascariifolius is characterized by the innumerable, elevated and crowded lenticels, very much resembling a crowded colony of plant lice (aphids). Further, its chartaceous and oblanceolate-oblong leaves are distinctive.

31. CELASTRUS MERIDENSIS Pittier, in Bol. Soc. Venez. Cienc. Nat. 3:423. 1927. (T.: *Gebringer 298*, US!).

Maytenus meridensis (Pittier) Cuatr. in Fieldiana, Bot. 27[2]:82. 1951.

Scandent shrubs; branches slightly striate, glabrous, brownish, the lenticels sparse, elliptic, slightly elevated, white, obscure on the young branchlets; axillary buds ovoid, about 2 mm. long. Leaves ovate, ovate-oblong, or obovate, the apex rotund to abruptly acute, the base cuneate to rotund, the margins remotely crenate-serrate, 4.5–7.0 cm. long, 2–5 cm. wide, firmly chartaceous, glabrous, the primary lateral veins 5–7 pairs, elevated below, plane and distinct above, the veinlets visible below, obscure above; stipules filiform, about 1 mm. long; petioles 3–7 mm. long. Inflorescences axillary, simple, racemiform, up to 5 cm. long, the primary peduncles obscure, glabrous, the secondary peduncles about 1 mm. long, with 2 small prophylls; flowers bisexual, white, the pedicels obscure, accrescent, up to 3 mm. long on the fruiting specimens. Calyx lobes imbricate, ovate, rotund, slightly erose, thick, about 1.2 mm. long; petals oblong, obtuse, slightly erose, about 2.6 mm. long and 1.3 mm. wide; disc fleshy, flat, about 1.6 mm. in diameter, the lobes depressed, subreniform; stamens attached just beneath the disc margin, about 2 mm. long, the filaments linear, glabrous, the anthers ovoid, obtuse; pistil pear-shaped, about 1.5 mm. long, the style short, columnar and blunt. Fruits ovoid, the valves broadly ovate to suborbicular, about 11 mm. long and 7.5–9.0 mm. wide, the septa 2–3 mm. wide, 1-seeded; seeds ellipsoid, 7 mm. long and 5 mm. wide, reddish-brown, shining, the areolae obscure.

In thickets, at altitudes 2,490–2,700 m.; Colombia and Venezuela; flowering in July.

COLOMBIA: Cordillera Oriental, Dept. Boyacá, *Cuatrecasas 1813*, *1831* (F, US).
VENEZUELA: Mucurubá, *Gebriger 298* (US, type; F, NY).

This species distinctly belongs to *Celastrus*. The morphological characters match the generic characters very well. The type specimen is a scandent, flowering plant. In addition to the type, I have several fruiting specimens at hand, which confirm this view.

Cuatrecasas[42] transferred this species to *Maytenus* based on his own collections (*1813* and *1831*, F, US). He says, "My specimens were obtained from trees, justifying their inclusion in the genus *Maytenus*". On examining the specimens, especially *Cuatrecasas 1813* US, one can see easily the twisted branches; it seems a scandent plant. Unfortunately, there is no habit data on the specimens. Since all the *Celastrus* species are scandent shrubs, I assume that Dr. Cuatrecasas' specimens "obtained from trees" were in reality scandent.

[42] In Fieldiana, Bot. 27[2]:82. 1951.

Doubtful Species

The type specimens or representative specimens of the following species are not available, while their original descriptions alone are not sufficient to place them.

Celastrus discolor Lévl. in Bull. Géogr. Bot. 24:142. 1914 (T.: *Cavalerie 3919*). China.

Celastrus grenadensis Urb. Symb. Antill. 5:51. 1904 (T.: *Eggers 6222*). Ind. Occ.

Celastrus microcarpus D. Don, Prod. Fl. Nep. 191. 1825 (T.: *Kamroop s. n.*). Reg. Himal.

Celastrus racemosus var. trinitensis Urb. Symb. Antill. 5:52. 1904 (T.: *Baptiste 5857*). Trinidad.

Celastrus repandus Bl. Bijdr. Fl. Ned. Ind. 1145. 1825 (T.: none). Java.

Celastrus reticulatus Wang in Chin. Jour. Bot. 2:68. 1937 (T.: *Leu 233*). China.

Excluded Species

From this list have been omitted all indigenous species of Africa proper, most of which are species of *Gymnosporia* or *Maytenus* and require special study of precise disposition.

Celastrus acuminatus Wall. Cat. no. 4342. 1831 = Chailletia gelonioides Hook. f. Fl. Brit. Ind. 1:570. 1875.

Celastrus adenophylla Miq. Ann. Mus. Bot. Lugd. Bat. 2:85. 1865=Ilex crenata Thunb. Fl. Jap. 78. 1784.

Celastrus alatus Thunb. Fl. Jap. 98. 1784 = Euonymus thunbergianus Bl. Bijdr. Fl. Ned. Ind. 1147. 1825.

Celastrus alpestris Bl. Bijdr. Fl. Ned. Ind. 1145. 1825 = Perrottetia alpestris Loes. in Engl. & Prantl, Nat. Pflanzenfam. III, 5:220. 1892.

Celastrus aphyllus Schlecht. in Linnaea 15:458. 1841 = Acanthothamnus aphyllus Standl. in Contr. U. S. Nat. Herb. 23:684. 1923.

Celastrus aquifolius Regel, Ind. Sem. Hort. Pétrop. 36. 1856, nom. nud.

Celastrus attenuatus Wall. Cat. no. 4319. 1831 = Gymnosporia neglecta Lawson in Hook. Fl. Brit. Ind. 1:619. 1875.

Celastrus bilocularis F. Muell. in Trans. Phil. Inst. Vict. 3:31. 1859 = Maytenus bilocularis (F. Muell.) Loes. in Engl. & Prantl, Nat. Pflanzenfam. 2 Abt. 20b:135. 1942.

Celastrus bivalvis Jack, in Malay. Misc. 1:19. 1820 = Microtropis bivalvis Wall. Cat. no. 4340. 1831.

Celastrus boaria Baill. Hist. Pl. 6:26. 1877, in text, nom. nud. = Maytenus boaria Molina, Saggio Stor. Nat. Chile, ed. 1, 177. 1778.

Celastrus bodinieri Lévl. in Fedde, Rep. Sp. Nov. 13:263. 1914 = Ilex purpurea Hassk. Cat. Pl. Bogor. 230. 1844; Rehd. in Jour. Arnold Arb. 14:239. 1933.

Celastrus buxifolia Wall. in Roxb. Hort. Beng. 18. 1814, nom. nud.; Fl. Ind. ed.

Carey & Wall. 2:396. 1824, in syn.: *Celastrus rigidus* Wall. = GYMNOSPORIA WALLICHIANA Laws. in Hook. Fl. Brit. Ind. 1:621. 1875.

Celastrus cavaleriei Lévl. in Fedde, Rep. Sp. Nov. 13:262. 1914 = MYRSINE SEMISERRATA Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:293. 1824; Rehd. in Jour. Arnold Arb. 15:292. 1934.

Celastrus chungii Merr. in Sunyatsenia 3:253. 1937 = TRIPTERYGIUM WILFORDII Hook. in Benth. & Hook. Gen. Pl. 1:368. 1862–67.

Celastrus circumcissus Pavon, mss.; Briq. in Ann. Conserv. & Jard. Bot. Genève 20:253. 1919 = MAYTENUS ORBICULARIS (Willd.) Loes. in Engl. Bot. Jahrb. 50 (Beibl. 111):10. 1913.

Celastrus colombianus Cuatrec. in Fieldiana Bot. 27^2:81. 1951 = ILEX SCANDENS Cuatrec. in Lloydia 11:207. 1949.

Celastrus confertus Ruiz & Pavon, Fl. Peruv. 3:7. 1802 = MAYTENUS CONFERTUS (Ruiz & Pavon) Loes. in Engl. & Prantl, Nat. Pflanzenfam. 2 Abt. 20b:146. 1942.

Celastrus crenatus Forst. f. Prod. 19. 1786 = GYMNOSPORIA CRENATA (Forst.) Seem. Fl. Vit. 1:40. 1865.

Celastrus crenatus sensu F. Brown in Bull. Bishop Mus. Honolulu no. 130:158. 1935, non Forst. = GYMNOSPORIA sp., ex char.

Celastrus crenatus sensu Hook. & Arn. Bot. Beechey Voy. 61. 1841 = GYMNOSPORIA VITIENSIS (A. Gray) Seem. Fl. Vit. 1:41. 1865.

Celastrus crenatus Roth, Nov. Pl. Sp. 156. 1821 = GYMNOSPORIA MONTANA Benth. Fl. Austral. 1:400. 1863.

Celastrus crenulatus Wall. Cat. no. 4323. 1831, nom. nud.

Celastrus cuneifolius (Wr. ex A. Gray) Gomez de la Maza in Ann. Inst. Segunda Enseñanza 2:172. 1895 = EUONYMUS CUNEIFOLIUS C. Wright ex A. Gray in Mem. Am. Acad. n. s. 8:171. 1861—not *Celastrus* (capsules 2-valved).

Celastrus cunninghamii F. Muell. in Trans. Phil. Inst. Vict. 3:30. 1859 = MAYTENUS CUNNINGHAMII (F. Muell.) Loes. in Engl. & Prantl, Nat. Pflanzenfam. 2 Abt. 20b:136. 1942.

Celastrus cunninghamii var. *parviflora* F. M. Bailey in Queensland Agr. Jour. 29:178, *pl. 22*. 1912 = MAYTENUS CUNNINGHAMII (F. Muell.) Loes. in Engl. & Prantl, loc. cit. 1942.

Celastrus dilatatus Thunb. in Trans. Linn. Soc. 2:332. 1794 = ORIXA JAPONICA Thunb. Nov. Gen. Pl. 3:57. 1783.

Celastrus disperma F. Muell. in Trans. Phil. Inst. Vict. 3:31. 1859 = MAYTENUS DISPERMUS (F. Muell.) Loes. in Engl. & Prantl, Nat. Pflanzenfam. Abt. 2. 20b:135. 1942.

Celastrus diversifolia Hemsl. in Jour. Linn. Soc. 23:123. 1886 = GYMNOSPORIA DIVERSIFOLIA Maxim. in Bull. Acad. Sci. St. Pétersb. III, 27:459. 1881.

Celastrus dubia Spreng. Syst. Veg. 1:774. 1825—not *Celastrus* (capsules 2-valved).

Celastrus emarginatus Ruiz & Pavon, Fl. Peruv. 3:6, *t. 229, f. a*. 1802 = MAYTENUS RETUSA Briq. in Ann. Conserv. & Jard. Bot. Genève 20:351. 1919.

Celastrus emarginatus Willd. Sp. Pl. 1^2:1128. 1798 = GYMNOSPORIA EMARGINATA Thw. Enum. Pl. Zeyl. 409. 1864.

Celastrus esquirolianus Lévl. Fl. Kouy-Tchêou, 69. 1914 = RHAMNUS CRENATUS Sieb. & Zucc. in Abh. Bayer. Akad. Muench. II, 4:146. (Fl. Jap. Fam. Nat. 1:38). 1845; Rehd. in Jour. Arnold Arb. 15:13. 1934.

Celastrus esquirolii Lévl. in Fedde, Rep. Sp. Nov. 13:262. 1914 = SABIA PARVIFLORA Wall. var. NITIDISSIMA Lévl. Fl. Kouy-Tchéou, 379. 1915; Rehd. in Jour. Arnold Arb. 15:10. 1934.

Celastrus euonymoidea Lévl. Fl. Kouy-Tchéou, 419. 1915 = GREWIA FEDDEI (Lévl.) Burret in Notizbl. Bot. Gart. Berlin 9:678. 1926.

Celastrus fasciculatus Drake in Grandidier, Hist. Phys., Nat., e Pol. de Madag. 35 (Hist. Nat. Pl. Atlas 3:*pl. 280*). 1896 = GYMNOSPORIA sp., ex ill.

Celastrus feddei Lévl. in Fedde, Rep. Sp. Nov. 13:263. 1914, quoad specim. *Esquirol 3189* = GREWIA HENRYI Burret in Notizbl. Bot. Gart. Berlin 9:674. 1926; Rehd. in Jour. Arnold Arb. 18:221. 1937.

Celastrus feddei Lévl. in Fedde, Rep. Sp. Nov. 13:263. 1914, excl. *Esquirol 3189* = GREWIA FEDDEI (Lévl.) Burret, loc. cit. 678. 1926.

Celastrus finlaysonianus Wall. Cat. no. 4324. 1831, nom. nud.

Celastrus floribundus Span. in Linnaea 15:186. 1841, nom. nud.

Celastrus fournieri Panch & Sebert, Not. Bois Nouv. Caléd. 234. 1874 = MAYTENUS FOURNIERI (Panch. & Sebert) Loes. in Engl. & Prantl Nat. Pflanzenfam. 2, Abt. 20b:138. 1942.

Celastrus glaucus Vahl, Symb. Bot. 2:42. 1791 = ELAEODENDRON GLAUCUM Pers. Syn. Pl. 1:241. 1805.

Celastrus haenkea Spreng. Syst. Veg. 4^2:88. 1827 = SCHOEPFIA FLEXUOSA Roem. & Schult. Syst. Veg. 5:160. 1819.

Celastrus hamelii Spreng. Syst. Veg. 1:774. 1825 = RHAMNUS RACEMOSUS Duham. Traité Arb. et Arbust. ed. nov. 3:48. 1806.

Celastrus heterophyllus Savi in Mem. Accad. Sci. Torino 38:163 (Mem. de C. G. Savi, p. 11, *tab.* II, *f. 2.*). 1835—not *Celastrus* (fruit triangular).

Celastrus heyneana Roth in Roem. & Schult. Syst. Veg. 5:421. 1819, p. p. = GYMNOSPORIA HEYNEANA Laws. in Hook. Fl. Brit. 1:620. 1875.

Celastrus ilicifolius Schrad. in Goett. Gel. Anz. 1:716. 1821 = MAYTENUS TRUNCATUS Reiss. in Mart. Fl. Bras. 11^1:5. 1861.

Celastrus japonicus (Thunb.) Koch, Dendrol. 1:625. 1869 = ORIXA JAPONICA Thunb. Nov. Gen. Pl. 3:57. 1783.

Celastrus jodinii Steud. ex Göpp. in Gartenflora 3:312. 1854, in obs.: *Ilex cuneifolia* Hook. f. = TRICHILIA JODINII (Steud. ex Göpp.) Briq. in Candollea 6:21. 1935.

Celastrus kouytchensis Lévl. in Fedde, Rep. Sp. Nov. 13:264. 1914 = RHAMNUS CRENATUS Sieb. & Zucc. in Abh. Bayer. Akad. Müench. II, 4:146. (Fl. Jap. Fam. Nat. 1:38.) 1845.

Celastrus leptopus Drake in Grandidier, Hist. Madag. 35. (Hist. Nat. Pl. Atlas 3, *pl. 280*^{A}). 1896 = GYMNOSPORIA sp., ex ill.

Celastrus linearis var. *madagascariensis* Drake in Grandidier, loc. cit., *pl. 280*^{B}. 1896 = GYMNOSPORIA sp., ex ill.

Celastrus lineatus (Wr.) Gomez de la Maza in Ann. Soc. Españ. Hist. Nat. 19:239. 1890 = MAYTENUS LINEATUS C. Wr. in Griseb. Cat. Pl. Cub. 54. 1866.

Celastrus listeri Prain in Jour. Asiat. Soc. Beng. 73:197. 1904 = Gymnosporia sp.

Celastrus lucida Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:400. 1824—not *Celastrus* (ovary many-celled).

Celastrus lycioides Bross. ex Willd. in Roem. & Schult. Syst. Veg. 5:427. 1819—not *Celastrus* (branches spiny).

Celastrus lyi Lévl. in Fedde, Rep. Sp. Nov. 13:264. 1914 = Rhamnus esquirolii Lévl. in Fedde, Rep. Sp. Nov. 10:473. 1912.

Celastrus macrocarpus Ruiz & Pavon, Fl. Peruv. 3:8, *t. 230, f. b.* 1802 = Maytenus macrocarpus (Ruiz & Pav.) Briq. in Ann. Conserv. & Jard. Bot. Genève 20:361. 1919.

Celastrus ? magellanicus DC. Prod. 2:8. 1825 = Maytenus magellanicanus Hook. f. Fl. Antarct. 254. 1847.

Celastrus mairei Lévl. in Fedde, Rep. Spec. Nov. 13:264. 1934 = Sabia yunnanensis Franch. in Bull. Soc. Bot. Fr. 33:465. 1886; Loes. in Ber. Deut. Bot. Ges. 32:543. 1914.

Celastrus mauritiana Stadtm. ex Willem. in Ust. Ann. Bot. 18:22. 1798; Roem. & Schult. Syst. Veg. 5:428. 1819—not *Celastrus* (leaves ternate).

Celastrus maytenus Willd. Sp. Pl. 1^2:1127. 1798 = Maytenus boaria Molina, Saggio Stor. Nat. Chile ed. 1. 177. 1778.

Celastrus mexicanus Moc. & Sessé ex DC. Prod. 2:8. 1825 = Wimmeria mexicana (Moc. & Sessé) Lundell in Bull. Torr. Bot. Club 67:618. 1940.

Celastrus micrantha Roxb. Hort. Beng. 86. 1814, nom. nud.; Fl. Ind. ed. Carey & Wall. 2:393. 1824—not *Celastrus* (leaves pinnate).

Celastrus mollis Decne. in Rev. Hort. II, 4:425. 1845–46—not *Celastrus* (leaves opposite).

Celastrus montana Roth ex Roem. & Schult. Syst. Veg. 5:427. 1819; Roth, Nov. Pl. Sp. 154. 1821=Gymnosporia montana Benth. Fl. Austral. 1:400. 1863.

Celastrus moya O. Kuntze, Rev. Gen. 3^2:37. 1898 = Moya spinosa Griseb. Pl. Lorentz. 63, *pl. 1, f. 3.* 1874.

Celastrus muelleri Benth. Fl. Austral. 1:399. 1863 = Maytenus sp.

Celastrus myrtifolius Linn. Sp. Pl. 196. 1753 = Prunus myrtifolia (Linn.) Urban, Syn. Ant. 5:93. 1904.

Celastrus neglecta Wall. Cat. no. 4341. 1831 = Gymnosporia neglecta Laws. in Hook. Fl. Brit. Ind. 1:619. 1875.

Celastrus nepalensis Steud. Nom. ed. 2, 1:315. 1840 = Pittosporum floribundum Wight & Arn. Prod. Ind. Orient. 154. 1834.

Celastrus obtusatus Presl, Bot. Bemerk. 34. 1844 = Simmondsia californica Nutt. in Hook. Lond. Jour. Bot. 3:400, *t. 16.* 1844.

Celastrus obtusifolia Roxb. Hort. Beng. 86. 1814, nom. nud.; Fl. Ind. ed. Carey & Wall. 2:393. 1824 = Gymnosporia trigyna Baker, Fl. Maurit. 50. 1877.

Celastrus octogonus L'Hér. Sért. 7. 1788 = Maytenus orbicularis (Willd.) Loes. in Engl. Bot. Jahrb. 50 (Beibl. 111):10. 1913.

Celastrus opposita Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:398. 1824 = PLEUROSTYLIA COCHINCHINENSIS Pierre, Fl. For. Cochinch. Fasc. 20, sub. *t. 305*, in text. 1894.

Celastrus orbicularis Willd. mss. ex HBK. Nov. Gen. et Sp. Pl. 7:65. 1825 = MAYTENUS ORBICULARIS (Willd.) Loes. in Engl. Bot. Jahrb. 50(Beibl. 111):10. 1913.

Celastrus orixa Sieb. & Zucc. in Abh. Bayer. Akad. Muench. II, 4:150. 1845 = ORIXA JAPONICA Thunb. Nov. Gen. Pl. 3:57. 1783.

Celastrus ovalifolius Steud. Nom. Bot. ed. 2, 1:315. 1840 = GYMNOSPORIA OVATA Laws. in Hook. Fl. Brit. Ind. 1:619. 1875.

Celastrus ovatus Hill. Veg. Syst. 13:62, *f. 12*. 1824 = COLUBRINA FERRUGINOSA Brongn. in Ann. Sci. Nat. I, 10:369. 1827.

Celastrus ovatus Wall. Cat. no. 4308. 1831 = MAYTENUS OVATA (Wall.) Loes. in Engl. & Prantl, Nat. Pflanzenfam. 2 Aufl. 20b:140. 1942.

Celastrus oxyphyllus Wall. Cat. no. 4312. 1831 = GYMNOSPORIA ACUMINATA Hook. Fl. Brit. Ind. 1:619. 1875.

Celastrus pallidus Wall. Cat. no. 4307. 1831 = GYMNOSPORIA MONTANA Benth. Fl. Austral. 1:400. 1863.

Celastrus parviflorus Vahl, Symb. Bot. 1:21. 1790 = GYMNOSPORIA sp.

Celastrus parvifolius A. Rich. Ess. Fl. Cub. 349. 1845—not *Celastrus* (fruits 2-valved and 1- to 2-seeded).

Celastrus pauciflora Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:400. 1824—not *Celastrus* (ovary 1-celled).

Celastrus pentagyna Zipp. ex Span. in Linnaea 15:186. 1841, nom. nud.

Celastrus quadrangulatus Schrad. in Goett. Gel. Anz. 1:716. 1821 = MAYTENUS QUADRANGULATUS (Schrad.) Loes. in Engl. & Prantl, Nat. Pflanzenfam. 2 Aufl. 20b:142. 1942.

Celastrus retusa Poir. in Lam. Encycl. Méth. Suppl. 2:146. 1811 = MAYTENUS RETUSA Briq. in Ann. Conserv. & Jard. Bot. Genève 20:351. 1919.

Celastrus rhombifolius Hook. & Arn. in Hook. Bot. Misc. 3:170. 1833 = IODINA RHOMBIFOLIA Hook. & Arn. ex Reissek, in Mart. Fl. Bras. 11^1:78. 1861.

Celastrus richardi Gomez de la Maza, Dicc. Bot. Nom. Vulg. 25. 1889 = MAYTENUS BUXIFOLIUS Griseb. Cat. Pl. Cub. 53. 1866.

Celastrus richardi γ. *latifolius* Gomez de la Maza in Ann. Soc. Españ. Hist. Nat. 19:239. 1890, nom. nud.

Celastrus richardi δ. *cochlearifolius* Gomez de la Maza, loc. cit. 239. 1890 = MAYTENUS COCHLEARIFOLIUS Griseb. Cat. Pl. Cub. 53. 1866.

Celastrus richardi ε. *elaeodendroides* Gomez de la Maza, loc. cit. 239. 1890 = MAYTENUS ELAEODENDROIDES Griseb. loc. cit. 54. 1866.

Celastrus rigida Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:396. 1824 = GYMNOSPORIA WALLICHIANA Laws. in Hook. Fl. Brit. Ind. 1:621. 1875.

Celastrus robustus Roxb. Hort. Beng. 18. 1814, nom. nud.; Fl. Ind. ed. Carey & Wall. 2:395. 1824 = KURRIMIA sp.

Celastrus rothianus Wight & Arn. Prod. Fl. Ind. Orient. 1:159. 1834 = GYMNOSPORIA ROTHIANA Laws. in Hook. Fl. Brit. Ind. 1:620. 1875.

Celastrus royleanus Wall. Cat. no. 4317. 1831 = GYMNOSPORIA ROYLEANA Laws. loc. cit. 620. 1875.

Celastrus rufa Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:397. 1824 = GYMNOSPORIA RUFA Laws. loc. cit. 620. 1875.

Celastrus salicifolia Lévl. in Fedde, Rep. Sp. Nov. 13:263. 1914 = ILEX MACROCARPA Oliv. in Hook. Icon. Pl. 18:*t. 1787*. 1888; Rehd. in Jour. Arnold Arb. 14:242. 1933.

Celastrus seguini Lévl. in Fedde, Rep. Spec. Nov. 13:262. 1914 = MYRSINE SEMISERRATA Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:293. 1824.

Celastrus semiarillata Turcz in Bull. Soc. Nat. Mosc. 36[1]:599. 1863—not *Celastrus* (branches spiny).

Celastrus sepiarius Dennst. Schlüs. Hort. Ind. Malab. 31. 1818, nom. nud.

Celastrus serrulatus Roth, Nov. Pl. Sp. 155. 1821, p. p. = GYMNOSPORIA ROTHIANA Laws. in Hook. Fl. Brit. Ind. 1:620. 1875.

Celastrus spicatus Vell. Fl. Flum. 92, *t. 138*. 1827 = GOUANIA CORYLIFOLIA Raddi, in Mem. Soc. Ital. (Modena) 18, *f. 394*. 1820.

Celastrus spinifolius Larrañaga, Escritos D. A. Larrañaga 2:96. 1923—not *Celastrus* (capsules bivalved).

Celastrus spinosus Royle, Ill. Bot. Himal. 157. 1835 = GYMNOSPORIA ROYLEANA Laws. in Hook. Fl. Brit. Ind. 1:620. 1875.

Celastrus striatus Thunb. Fl. Jap. 98. 1784 = EUONYMUS ALTUS (Thunb.) Sieb. Syn. Pl. Oecon. Jap. 49. 1830.

Celastrus suaveolens Lévl. in Fedde, Rep. Sp. Nov. 13:263. 1914 = ILEX SUAVEOLENS (Lévl.) Loes. in Ber. Deut. Bot. Ges. 32:541. 1914.

Celastrus tetramerus Standley in Contr. U. S. Nat. Herb. 23:679. 1923 = PHYLLANTHUS sp.

Celastrus tristis Lévl. in Fedde, Rep. Sp. Nov. 13:263. 1914 = RHAMNUS NAPALENSIS (Wall.) Laws. in Hook. Fl. Brit. Ind. 1:640. 1875.

Celastrus uncinatus Ruiz & Pavon, Fl. Peruv. 3:7, *t. 230, f. a*. 1802 = MAYTENUS BOARIA Molina, Saggio Stor. Nat. Chile, ed. 1, 177. 1778.

Celastrus variabilis Hemsl. in Jour. Linn. Soc. 23:124. 1886 = GYMNOSPORIA VARIABILIS Loes. in Engl. Bot. Jahrb. 29:446. 1900.

Celastrus verticillata Roxb. Hort. Beng. 18. 1814, nom. nud.; Fl. Ind. ed. Carey & Wall. 2:391. 1824 = PITTOSPORUM FLORIBUNDUM Wight & Arn. Prod. Fl. Ind. Orient. 154. 1834.

Celastrus verticillatus Ruiz & Pavon, Fl. Peruv. 3:6, *t. 229, f. b*. 1802 = MAYTENUS VERTICILLATUS DC. Prod. 2:10. 1825.

Celastrus vitiensis (A. Gray) [incorrectly ascribed to Benth. & Hook. by] Drake, Fl. Polyn. France, 30. 1893 = CATHA VITIENSIS A. Gray, Bot. Phanerog., Wilkes U. S. Expl. Exped. 287, *t. 23*. 1854 = GYMNOSPORIA VITIENSIS (A. Gray) Seem. Fl. Vit. 40. 1865.

Celastrus wallichianus Spreng. Syst. Veg. 5, Index 150. 1828 = GYMNOSPORIA WALLICHIANA Laws. in Hook. Fl. Brit. Ind. 1:621. 1875.

Celastrus wallichianus Wall. in Roxb. Fl. Ind. ed. Carey & Wall. 2:400. 1824 = GYMNOSPORIA WALLICHIANA Laws. in Hook. loc. cit. 621. 1875.

Celastrus wallichii G. Don, Gen. Syst. 2:8. 1832 = CELASTRUS LUCIDA Wall., non Linn.—not *Celastrus*.

Celastrus wightianus Wall. Cat. no. 4332. 1831 = PLEUROSTYLIA COCHINCHINENSIS Pierre, Fl. For. Cochinch. Fasc. 20, sub. *t. 305* in text. 1894.

Celastrus yunnanensis Lévl. Cat. Pl. Yun-Nan, 32. 1915 = PREMA PARVILIMBA P'ei in Mem. Sci. Soc. China 1:62. 1932; Rehd. in Jour. Arnold Arb. 15:324. 1934.

Celastrus zeylanica Roth ex Roem. & Schult. Syst. Veg. 5:427. 1819 = SCUTIA COMMERSONII Brongn. in Ann. Sci. Nat. I, 10:363. 1827.

ENUMERATION OF THE SPECIES

SUBGENUS I. CELASTRUS

SERIES 1. PANICULATI

1. *paniculatus* Willd.
   - 1a. ssp. *paniculatus*
   - 1b. ssp. *serratus* (Blanco) Ding Hou
   - 1c. ssp. *multiflorus* (Roxb.) Ding Hou
2. *novoguineensis* Merr. & Perry
3. *subspicatus* Hook. f.
4. *richii* A. Gray
5. *madagascariensis* Loes.
6. *angulatus* Maxim.
7. *scandens* Linn.

SERIES 2. AXILLARES

8. *monospermus* Roxb.
9. *monospermoides* Loes.
10. *hindsii* Benth.
11. *glaucophyllus* Rehd. & Wils.
12. *hookeri* Prain
13. *membranifolius* Prain
14. *vanioti* (Lévl.) Rehd.
15. *hypoleucus* (Oliver) Warburg
16. *gemmatus* Loes.
17. *orbiculatus* Thunb.
18. *rosthornianus* Loes.
19. *punctatus* Thunb.
20. *kusanoi* Hayata
21. *hirsutus* Comber
22. *stylosus* Wall.
    - 22a. ssp. *stylosus*
    - 22b. ssp. *glaber* Ding Hou
23. *aculeatus* Merr.
24. *flagellaris* Rupr.

SUBGENUS II. RACEMOCELASTRUS

25. *lenticellatus* Lundell
26. *racemosus* (Reiss.) Loes.
27. *panamensis* Lundell
28. *pringlei* Rose
29. *vulcanicolus* Donn. Smith
30. *caseariifolius* Lundell
31. *meridensis* Pittier

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Italicized numerals refer to collectors' numbers, *s. n. (sine numero)* to unnumbered collections; parenthetical numerals refer to the numerals of the species conserved in this revision.

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I—INTRODUCTION

We moved to the village of Karimpur in the autumn of 1925. My husband and I had found during our years in India that if we were to understand the people of the villages, we must not be content to visit them, but we must live among them. After a study of the villages in the district, we chose Karimpur for our village home. Uninvited, we moved our tents and belongings into a mango grove on the edge of the village. In our ignorance we thought that our village neighbours would be glad to see us. But they showed no inclination to welcome white strangers, and were decidedly aloof until we had proven ourselves harmless. When they did finally accept us, they took our residence among them seriously, and saw no reason why we should ever leave.

We thought, in the beginning, that a few months would give us what we ought to know of custom, activity, and thought. But when the hot season of 1926 arrived and we were obliged to retreat to a bungalow in the town of Mainpuri, five miles away, we had just begun to appreciate our ignorance. We commuted to the village from the town during the summer, and returned to live in it as soon as the heat was bearable in tents. We repeated this migration annually until the spring of 1931, when we left for America.

My intention was that I should act as the good will of the study. With one son five, and another not yet two, I felt that I had all that I could undertake. But the village women, confined to their courtyards, could not come to me. They kept calling me to them. And as I saw more of them and their share in family activities, I realized that to understand and interpret the life of the village, we must know more about the women. They are of much more importance, economically, than most students of Indian villages have given them credit for being. Observations in this field led me into further interest in their share in the care and preparation of foods.

Meanwhile, the increasing number of calls on us for medical help impressed on us the futility of trying to cure ills while the causes of those ills went unquestioned. This led me into a study of village food from the point of view of health. I knew very little about food. But I had to acknowledge that if I wanted to understand and help Indian village women I must learn more about food, particularly their food. And out of this need grew the present study.

I learned all that I could about the foods procurable and the foods used, of food preparation and food customs. This material I carried to America, and with the help of specialists in the fields of nutrition and biological chemistry, I attempted to evaluate the foods eaten in our village, and to study the effect of customary methods of preparation on food values. The work was supervised by Miss Helen Monsch, head of the Department of Foods and Nutrition at Cornell University.

Miss Monsch and other members of the staff, especially Miss Mary Henry and Miss Marion Pfund, helped in the study of the chemistry of foods, and in securing standard tables of food values. Others who made the work possible were Dr. J. B. Sumner, Professor of Biological Chemistry, and Dr. L. A. Maynard and Dr. C. M. McCay, both of whom have much to bring to the field of human nutrition from their researches in animal nutrition.

I—A DESCRIPTION OF KARIMPUR AND ITS PEOPLE

Karimpur, the village of our study, is in the northern part of India, in the much fought over Ganges plain. This section of the country is known, under British rule, as the United Provinces of Agra and Oudh. The latitude of Karimpur is 27° 9″ North, about that of Palm Beach, Florida. The climate, however, is more continental than that of Palm Beach, and might better be compared with the same latitude in Mexico. The winters are delightful. In October, the heat relaxes, and the weather is progressively cooler until January when the mean temperature is 48.7° F. For us these are the months of refreshment. But for village families with lives regulated for hot seasons and no provision for cold, January and February are months of misery. In March the hot winds begin to blow, and from then until June the temperature rises steadily to a mean maximum of 112° F. The rainy season begins in July: over 60 per cent of the annual rainfall comes in July and August. The temperature drops only slightly but the rain brings relief to men and fields. September, at the end of the rains, with its heat and humidity, unrelieved by rain, is the most trying month for all of us. It is made endurable by the thought that the siege of heat cannot last much longer.

Karimpur is in an area which has played an important part in the history of India. Not far away are Kanauj, capital of the Harsha dynasty (A.D. 604), and Kampiyala, the stronghold of the Panchalas, heroes of the Indian epic, Mahabharata (before 400 B.C.). Sixty-five miles to the south-west is Agra, with its Taj Mahal, and great fort of the Moghuls.

Agra is the nearest city. Cawnpore, next nearest, is 110 miles south. As yet, neither city has made its influence felt in Karimpur. There are two market towns which link the village with the outside world. One is Kuraoli, 7½ miles to the north, with a population of 4,717. The other is Mainpuri, 5½ miles south. The population of Mainpuri is 15,599. Farmers of Karimpur take their surplus produce to either of these market towns to sell, and while on such an expedition, they may stop to buy clothing or food not available in the village. But they fear the clever merchants of the town, and avoid dealing with them as far as possible. They prefer to confine their activities to the village, with the minimum of outside contacts. Mainpuri is the official headquarters of the district. This necessitates trips to the Mainpuri courts to settle major disputes, chiefly those over land. But such trips are costly and confusing to farmers. And they prefer, if possible, to settle their disagreements at home with the advice of their own village council.

This aloofness has protected the Hindu culture of Karimpur from inroads of changing dynasties—an important reason why it is a good field for our study of Hindu foods. It shares this advantage with other villages of the district. But it has additional points in its favour. Mainpuri District covers 1,675 square miles and includes 1,388 inhabited towns and villages. Two hundred and five of these have a populaton of over 1,000, and are too large to be representative. Of the 1,183 under 1,000, many are very small and confined to few castes, and often to only one or two industries. Karimpur, with its population of 754, presents a variety of castes (seventeen), as well as two groups or castes of outcastes, four groups of Muhammadans, and several families of Christians. It is dominated by Brahmans, which strengthens its barriers against foreign ideas. Like most of North India, farming is its outstanding occupation, with the subsidiary industries needed in a self-supporting community.

The dusty, mango-shaded highway from Mainpuri to Karimpur, winds northward through a patchwork of small, oddly shaped farm plots separated from one another by low mounds of earth or narrow irrigation ditches. Sometimes there is an open stretch of uncultivated land which is too alkaline for crops, but which puts forth a stubby growth sufficient for meagre grazing. The animals must keep moving and searching if they are to keep alive. One is impressed by the leanness of the cows, and the thinness of the small boys who herd them. There are no houses on the farm plots. But there are hamlets, not much more than a mile apart, where the houses of farmers are huddled together. They are at a distance from the highway and easily passed unnoticed, with their monotonous gray walls.

If one were to follow this highway a few miles further north, he would come to the old Grand Trunk Road travelled by Kipling's Kim. Five and a half miles out from Mainpuri is the village of Karimpur. There are two small sections of the village directly on the highway, while the village proper stands back 200 yards to the east.

The first of the roadside sections is Chamar Nagariya, home of leather-workers. The leather-workers are counted as outcastes, but not as untouchables. All of the leather-workers' families save one, live in this section. It consists of just two enclosures side by side, with a high mud wall extending across the front of both of them. Along two sides of each enclosure are small rooms, one room to a family. The men who live here wear scant loin wrappings, and no shirt except in cold weather. They are dark-skinned. Their legs are long and spindling, and their knees and ankles bulge conspicuously. Their ribs and shoulder blades stand out, and their arms seem disproportionately long, like their legs. Their faces are deeply lined. Their teeth are ground down, and dark. The women's bodies are covered by long skirts, badly torn, but still so full that they are a protection. Over their heads they wear stained, grayish scarves, and some have short vests. One or two have smoother lines than the men, but the others have the same long thin arms and hard, bony hands. The boys and girls are dressed like their elders, and look like them except for their fuller faces, fewer wrinkles and better teeth. The babies are

plump and laughing. They go unclad when it is warm, and wear short vests when it is cold.

The other section by the roadside is Kachhi ka Nagla, hamlet of vegetable growers. They are true farmers by right of caste, along with the family of rice-growers which lives in the section with them. Although poor and in debt to Brahmans, they are independent, which may account for their living apart from the rest of the village. Among them we have the nearest approach to the joint-family that we find in the village. High mud walls enclose each joint-family, with its animals, its implements and its stores of grain—all of its possessions except land. The men, dressed in loin cloths, are short and slight but not as gaunt as the leather-workers. Their dark skin fits more smoothly over bone and muscle. One of their elders might be mistaken for Gandhi, especially since a cataract operation has made it necessary for him to wear spectacles. The women are small and thin, and their babies are plump and placid. The older children are copies of their parents.

As one turns east and bumps over the remnants of irrigation ditches which cut across the dirt road, to the village proper, he sees a long line of almost unbroken mud walls. He can guess where one man's wall ends and his neighbor's begins, only by the differences in height and smoothness of different portions of the wall. At the north end and at the south of this long wall there is a cluster of small, low-walled enclosures, each cut off from contact with the main wall by a lane. These are occupied by two castes of outcastes. Those living on the southern end are mat-makers, who make their living as farmhands. Their wives serve as midwives. The men are small and most of them are as thin as the leather-workers. But the arms and shoulders of the young women curve smoothly. And their skirts do not hang from protruding hip bones, like the leather-worker women, but from plump hips and abdomens. The outcastes at the northern end are the village scavengers, and therefore untouchables. They have recently been baptized as Christians, but are still regarded as untouchables by the villagers. Here too, the men are thin, with three exceptions. The younger women are attractively smooth-skinned, while the middle-aged and older women look tired, and their dark skin is drawn tightly over broad cheek bones, and hangs loose and dry between sharp elbow and wrist. In this group of untouchables one finds the darkest skins, the flattest noses, and the broadest faces in the village—evidences of Dravidian heritage.

Between the two outcaste communities there extends the long line of walls of caste enclosures. And beyond these enclosures are more like them, with the same high walls and small doorways. As far as possible they are built side to side and back to back, the only break being an occasional narrow lane or footpath leading to enclosures deeper in the village. If one is a stranger, he may follow any of the footpaths through the village and see only high gray barriers and blank doorways leading to stables. The stable is the entry-way to every enclosure. But if he is a friend, he sees the family enclosures overflowing into the paths. Children, puppies and goats tumble under his feet. Carpenters and potters carry on their work in the lanes before their doorways. And serving women salam him as they pass by

with head scarves drawn down over their faces. No matter how good a friend he may be, he never enters an enclosure other than his own. If it is necessary for a carpenter to repair a door frame or a beam, a man of the house accompanies him inside and remains until the work is finished. Women of serving castes are obliged to leave their own homes to work, but those of higher castes are jealously hidden within high-walled courtyards behind high-walled stables.

The families of each caste live close together, preferably in adjoining enclosures. The Brahmans (188) occupy the whole eastern section of the village. They are of priest-class by birth, but in practice they are farmers. Below them in the caste scale, in the order of their rank, are: bards (15), accountants (6), goldsmiths (10), flower growers (17), vegetable growers (152), rice growers (6), carpenters (42), barbers (2), water bearers (83), shepherds (26), grain parchers (10), seamsters (21), potters (9), tradesmen (14), oil pressers (10). In addition there are the outastes—washermen (6), mat-makers (28), and leather-workers (29). There are also the Christian sweepers (35); and four groups of Muhammadans—faquirs or beggars (23), bangle sellers (10), cotton carders (9), and dancing girls (3). The numbers given include all members of each caste, not just the members who are actually engaged in the caste industry. All of these, caste and outcaste, serve the Brahman farmers, and at the same time are able to exchange services with each other.

It is comparatively easy to recognize a Brahman. Even the older men among them who are bowed and withered, retain the bearing and features which mark them as Brahmans. There are exceptions, but one is fairly safe in picking the tallest, straightest, most firm-limbed young men as Brahmans. Their skin is fairer and their features finer than those of lower castes. Their noses are high and narrow. The Brahman women, always kept safely in the courtyards of their family enclosures, work as hard as other women. But they too have the fair skin, the narrow noses and faces, the firm, smooth bodies which set them apart from others of the village. None of them is fat. We have known only one fat person in the village, a woman of carpenter caste. Her fat was diagnosed as a symptom of her diseased condition. Brahman babies seem no plumper than others, and when weaned, they pass through the same period of loss in weight and resistance as do low caste babies. But if they survive this precarious stage, they surpass other children in weight, height, and strength. Smallpox scars and inflamed eyes are less common among Brahmans than among other castes.

Passing down from the Brahmans, the next three castes compare with them favourably. The goldsmith brothers are the village wrestlers, and are fed and massaged with this in view. Below them there is a decline in the evidences of well-being. From appearances it would be impossible to ascertain to what caste a man, woman or child of the humbler levels belongs. Sometimes an individual family gives its children a little better care than others, but such families are not confined to any one caste. A few Muhammadans may be recognized because of their more hawk-like noses. And the Christians are set apart by the consciousness of their

untouchability and their broader Dravidian features. Aside from these differences, all are very much alike. One becomes so accustomed to signs of insufficient food and care that his attitude toward standards of living is apt to shift.

Most of the men and women of the lower castes are angular, with hollows where flesh should be smooth. Bodies go unbathed, in contrast to higher castes where pour-over baths are supposed to be a part of the day's routine. They sleep and work in the same garments, and change them once in two or three weeks, whenever the washerman collects them to wash in the village pond. He uses cold water, beats the clothes on a rock, and spreads them on the dusty ground to dry. After a few washings a garment takes on the shade of gray of the earth and mud walls. The men's hair is cut short, with one long lock at the top. The women and girls do not use combs, and their hair tangles and mats, and offers refuge to multitudes of lice. Smallpox scars and eye infections or disfigurement are so common as to excite no comment. Both men and women work to the limit of their strength, and are thankful if they can earn enough food to make it possible for them to perform the tasks required of them. They do not hope for more, except on festival days when Brahman housewives hand out bread or cakes to the women and children of families performing regular services for them. The boys who run about the village lanes, or herd cows or sheep are small, lithe, and active, ready for any sort of fun. The little girls are the same. But before they are ten, they retire demurely to the courtyards where they care for their baby brothers or cousins, and imitate their mothers. The life cycle of the women is briefer than ours. The girls mature earlier—at ten or eleven—, are married at twelve or thirteen, and go to live in their husband's homes when fourteen or fifteen. From this time on, they are treated as grown women, capable of carrying a full share of the heavy work of farm households. They begin bearing children in the next two or three years, and although they do not have many babies, there is a constant sex-strain on their bodies. All of their work is done sitting or squatting on the ground, which is less wearying than standing. In spite of this, almost every mature woman of the village complains of the dragging down of her body. While we, in our early thirties, are facing the choice between a career and rearing a family, they are ready to sit back and tell their daughters-in-law how to feed their babies. The Indian Year Book for 1931 gives the mean age of males as 24.8 and of females as 24.7, according to the 1921 census.

II—FOOD SOURCES

The families of Karimpur retain their customary aloofness in meeting the problem of food supply. They prefer to accept the limitations of their own immediate environment, rather than venture into strange markets. Salt and spices are brought in from the outside, and sold by the small tradesmen. And an occasional purchase is made on a grain selling trip, or on a visit to a religious fair. These purchases are confined to familiar products which are considered a treat because of their limited

season or supply within the village. Unfamiliar products have no charm. About 40 miles from us is a district reputed for its oranges. These oranges are sold cheaply in the Mainpuri market during two winter months. But they are not brought home to the village. On the other hand, bananas are familiar, because a few are grown in the village. And bananas are brought from Mainpuri, when the price is sufficiently low. Each year tomatoes are sold in increasing quantities in the Mainpuri bazaar, but in the village the tomato is still a strange fruit, of an undesirable colour, and the villagers regard it with suspicion. Their diet is thus largely determined by the boundaries of their own fields. And it rises and falls with good and lean years. If the rains are favourable, and there have been no hail storms or destructive winds or pests, everyone has enough to eat. The villagers have learned to count on one or two such years out of every five. If the rains fail, or come too late, the whole village cuts rations. If one particular crop is damaged, they get along without it until it is harvested the following year.

Their exclusiveness does not limit their diet as much as one might expect. There may not be a variation in foods in one single day or in a week. But over a period of months there is considerable variety. The villager accepts his changes in food with the changing seasons. He is thus better prepared to welcome each new crop as it comes than is the town man who has greater variety each day. Still further, although the town man seems to have a greater choice of foods in the bazaar than the villager has in his fields, the villager has discovered many edible things which vary his diet and which rarely find their way to the town.

A—VARIETY OF FOODS MADE POSSIBLE BY CLIMATE AND SOIL

One reason why a greater variety of foods can be produced from a limited area, in the United Provinces than in Bengal and further south, is the greater distinction between the seasons. We have our hot dry summers when land rests, followed by warm rains which make crops of warm climates, like rice and sugarcane, possible. The rains are followed by a long dry season, a part of which is much cooler than Bengal, and which permits the growing of cold weather crops, such as wheat. One can better appreciate the variety of foods in Karimpur, by comparing them with the diet of less favoured districts. In his study of the use of food-grains in India, Church (1) found that "There are many districts in India where rice forms not merely the chief food-stuff but three-fourths or even four-fifths of its total amount. In some places it even rises to seven-eighths or to fifteen-sixteenths of the whole quantity, as in Burdwan, Dinajpur, Maldah, Kuch Behar, Manbhum, and Darrang; other districts might be named in which it constitutes the only food staple."

Another factor which contributes to the variety of the foods of our village is the variety of soils. The soils of Karimpur are typical of those of village communities of the Ganges plain. The following division of the revenue village is given in the latest Settlement report. These reports are made every twenty or thirty years by government settlement officers.

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(1) See References.

Revenue village of Karimpur

	Acres
Village sites	35
Covered with water	202
Otherwise barren	1,609
Culturable land	2,103
Miscellaneous land	144
	4,093

The 2,103 culturable acres are distributed as follows:

Type of land	Acres
Gauhan	39
Manjha wet	204
Manjha dry	18
Barha Dumat wet	554
Barha Dumat dry	242
Barha Bhur wet	518
Barha Bhur dry	160
Maiyar	68
Tarai	300
	2,103

"Gauhan" is the land immediately encircling the village. It is the best manured, and is rented at the highest rate. It may be any kind of soil, usually a loam, improved by constant manuring. Farmers prefer to grow maize, sugarcane, peas and potatoes on this soil, or on the next grade, which is listed as wet and dry "Manjha." "Manjha" is the same type of land as "gauhan," but it is the strip just outside the "gauhan," and therefore less manured and less desirable. Most of the vegetables are grown on one of these two soils, partly because of the improvement of the soil, and partly because vegetables require constant care and constant watering except during the rainy season. The outlying land is known as "barha." "Barha dumat" is a mixture of clay and sand in almost equal proportions. It is "generally of a rich brownish colour, adhesive without tenacity, briable [friable] without looseness, slippery and greasy when wet and with a soapy feeling when dry, and cutting like a cheese when ploughed wet." "Barha bhur" is outlying land which is "loose and sandy, and quite incapable of retaining moisture." (2)

The "dumat" will bear a large variety of crops, including wheat, barley, several varieties of millet, and pulses. Whereas the "bhur" is so sandy that crops which survive with the least irrigation are reserved for it. It is usually limited to spiked millet and coarse pulses. "Tarai" is the low lying land, which "includes all classes of natural soils from very heavy clays to loose sand." (3) In our area it is chiefly heavy clay.

On the "tarai," rice is usually grown, and sometimes water melons. In ordinary years it is swamped during the rainy season. "Maiyar" is "a stiff, unyielding clay of a dark colour, shrinking and cracking in dry weather into a network of

(2), (3) See References.

fissures, but expanding when moistened into a sticky clayey mass." (4). It can be made to produce some of the less desirable pulses, and millets, and perhaps rice.

Each farmer wants a share of the better land, and not too much of the poorer land. This has led to the partitioning of land into small, queerly shaped plots. A man may have as many as sixty or seventy plots scattered over the different kinds of soil in every direction from the village. R. Mukerjee writes of these scattered plots, "Various are the causes which tend to render a peasant's fields so widely scattered. In the village communities there was a deliberate attempt to distribute plots among the settlers in different soil areas so as to allot plots of different degrees of fertility to each . . . The Indian cultivator's farm tends to fly into fragments and grows steadily smaller and less regular. As the population increases, the holdings on account of the law of succession come to be unduly fragmented." And further on he refers to "the pepper pot distribution of holdings." (5)

The following table shows the proportions of each type of land included in the scattered plots of *J*, one of the largest land-holders of the village, and compares the proportions of his holdings with those of the same kinds of land of the whole village:

Percentage of each kind of land in Karimpur compared with percentage of same kind of land held by J, a Brahman

Kind of soil	Percentage in revenue village	Percentage in *J's* hereditary holding	Percentage in *J's* total holding
Gauhan	1.9	1.2	0.9
Manjha	10.6	15.3	15.1
Barha Dumat	37.8	47.9	46.2
Barha Bhur	32.2	22.3	21.0
Tarai	14.3	13.3	16.8
Maiyar	3.2	. .	. .
	100.0	100.0	100.0

"The hereditary holdings show the closest correlation because they conform more closely to the original division of land." (6)

With such an arrangement, each long-established family has a chance to raise a variety of crops, even though its acres are few. Poorer farmers, and those whose forefathers came in after the original division was made, may have little or none of the best land, and a larger share of undesirable land. But even they manage to get a variety of crops, by hard work and a resigned acceptance of inferior products as part of their inferior lot.

W. H. Moreland of the Civil Service discusses the management of farm land composed of scattered holdings, in his Agriculture of the United Provinces:

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(4), (5), (6) See References.

"Now, considering the variety of soils and of possible crops, this looks like a very complicated problem, and it is fortunate that the individual cultivator has not to face it without some guidance. The question has been attacked by many generations of cultivators and their accumulated experience is to be found in the *custom of the country* which guides the individual on such questions as what crops can be safely grown on hot soils, what crops will repay irrigation, what is the best means of distributing manure over the holding, in what order should crops be grown, and so on. This custom of the country is not an infallible guide to the most profitable utilization of the holding; the best course may never have been tried or may have been discarded through some mischance, or changes in the level of prices or as in the demand for particular products may make some changes in the custom desirable; but it is usually a safe guide to making a living, and the ordinary cultivator is well advised in following it rather than applying his limited intellect to working out a solution afresh."

And further on, he describes the arrangement of crops as actually practised:

"To see how this custom works out in practice, we may take the case of a holding of the ordinary size, say 5 or 6 acres, containing different soils. There may be a field of high sandy land; it cannot be irrigated and it dries so quickly that it would be very risky to sow winter crops on it: this land will usually have a rainy season crop. But even in the rains it is not very productive, for it will suffer from either wet or drought: not very much will be spent on its tillage, and it will usually be sown with cheap crops such as bajra (small millet) and moth (a pulse) which do fairly well on such land at a small expenditure. There may be another field of heavy clay; this will be regularly sown in the rains with rice, the only crop for which it is really fitted, while if possible some cheap pulse will be sown with rough tillage after the rice has been gathered. The rest of the holding consists, we will suppose, of irrigable loam. One portion of it, however, is so low lying that it is always more or less flooded in the rains: this portion will probably be sown regularly with a winter crop, which may sometimes be wheat and sometimes a mixture of wheat or barley with gram or peas. The rest of the land is suitable for either season and will be divided between the two in such a way that tillage can be effected in the time available. Possibly the cultivator will do this in the following way: taking the field nearest his house he will apply his manure to it and sow maize, which will be followed by some winter crop: another field he will put under great millet, arhar and urd (two pulses), with some sesamum to supply his house with oil, and a border of hemp to give fibre for well-ropes, etc.: the remaining land will be left for the winter and after manuring, sown with wheat along with a border of linseed or some lines of rapeseed, to supply more oil. In this way the cultivator would get an early supply of food from his maize, say about the end of August or September: rice in September or October; juar, bajra, urd and moth (two millets and two pulses) in November: pigeon peas and whatever cheap winter crops he had sown in March and April, when he would also have his wheat ready to sell for the rent.

"This is the holding of a cultivator of no special skill: a better man would get in a field of sugarcane or opium, or would manage to save more manure and take two crops in a year off a larger area, but the general principles will be the same: to secure sufficient food, with preferably an early supply in the rains; to have something to sell; to have a good variety of crops; and to arrange so that there may be time to till for all with the single pair of cattle which is all that a holding of this size can support." (7)

B—THE CROPS

One of the farming customs of the Ganges plain is the mixing of crops. Products intended for sale are kept unmixed. At least the farmer tries to keep them unmixed. But he is so accustomed to mixtures, that if barley or pigeon peas get into the wheat he sees nothing objectionable in the mixture. It is when his product reaches the city market, particularly where foreigners buy, that he is accused of adulteration. In his study of "Food-Grains of India," Church remarks, "The value of Indian wheats in European markets is often much lowered by preventable impurities. Very frequently they contain other cereal grains, especially barley; gram and linseed some times occur in them." (8) And McCay in his study of jail dietaries in the United Provinces, writes, "The chemical analyses of wheat in use in the different jails show greater variation than any other of the

(7), (8) See References.

food materials. This is practically entirely due to the different degrees of contamination with other grains, most of the samples in ordinary use were of second class quality and contained a large proportion of foreign grains." (9)

Wheat grown for home use is almost always mixed with the poorer quality cereals. Its presence makes bread made of barley or millet more palatable. And as long as the grains will be cooked together, they may as well be grown together. The more common mixtures have names, according to the grains they contain, and the proportions of each. "Gojai" is a mixture of wheat and barley. "Tirra" is wheat, barley and gram in equal parts. "Bejhar" may be equal parts of barley and peas, or equal parts of barley, gram and peas. Within the village, the selling or loaning of mixed grains can be carried on satisfactorily with the help of these names.

There are several advantages to the Karimpur farmer in raising mixed crops. A mixed crop may serve as insurance. A crop, such as rice, which flourishes in heavy rains, may be planted with a coarse millet, which flourishes in dry weather. Then, if the ground is flooded there will be rice, and if there is very little rain the rice may be lost, but there will be a millet crop. Sometimes two crops are grown together to save land. Millet and the pigeon pea are such a combination. The millet grows up more rapidly and the pigeon pea grows more slowly, until the millet is cut. As soon as the millet is cut the pigeon pea grows more rapidly, and when harvested yields about two-thirds of what it would without the millet. And the farmer is one millet crop ahead. In some cases a creeping pulse is grown with taller crops, to retain as much of the moisture in the ground as possible. Or a deep-rooted plant may be grown with one with shallow spreading roots. The most common crop mixture is that of at least one pulse with a cereal. The farmer does not know about nitrogen but he and his forefathers have found that the soil is benefited by the presence of a pulse. They have also discovered that pulse alone is not a satisfactory food. The mixture of pulse and cereal is the happy solution in the field and on the brass eating tray. The following record of his own crops, given us by a village cultivator, reveals the extent of crop mixing, particularly with food crops:

The grain crops of the village are familiar to us of the West except in the use for which some of them are intended. We in the United States regard certain millets, such as sorghum vulgare, as fodder crops, but in Karimpur they are grown as a complete family food—first for the human members of the family, and secondly for the animal members. Moreland, in his Agriculture of the United Provinces, remarks: "in many parts the cultivator cannot spare any part of his land solely for fodder crops, but must grow crops which will feed himself and his family as well as his cattle."

To a Westerner, the pulses are less familiar than the cereals. The "arhar," or pigeon pea, is the most common. Its yellow flowers colour the village fields during the cold season. It is one of the hardiest of the field crops. The peas, dried and

(9) See References.

Crops grown by a Karimpur farmer

Crop	Grown with	Reason for mixing
Wheat	1. Barley, or 2. Barley and gram	1. Mixed food. 2. Mixed food.
Barley	1. Gram, or 2. Wheat	1. Good for soil, and 2. Mixed food.
Field peas	Alone, or with wheat	Mixed food, and good for soil.
Sarson (mustard)	1. Wheat, or 2. Barley	Both save ground.
Gram	1. Wheat 2. Wheat and barley	Both for mixed food.
Duan (mustard)	1. Wheat, or 2. Barley	Both save ground.
Potatoes	Alone.	
Sugarcane	1. Hemp, or 2. Castor plant on border.	Both, 1 and 2, save ground.
Water melons	Alone.	
Little millet	Cotton	Saves ground.
Great millet	1. Pigeon pea, mung, or urd. 2. Mustard	1. Mixed food. 2. Saves ground.
Spiked millet	1. Moth (pulse) or pigeon pea. 2. Mustard	1. Mixed food. 2. Saves ground.
Maize	Alone.	
Rice	Alone.	
Pigeon pea	1. Millet 2. Cotton	1. Mixed food. 2. Saves ground.
Urd (pulse)	1. Millet 2. Cotton	1. Mixed food. 2. Saves ground.
Mung (pulse)	Millet	Mixed food.
Moth (pulse)	Spiked millet	Mixed food.
Ronsa (pulse)	1. Great millet 2. Spiked millet	Both, mixed food.
Cluster bean	1. Great millet 2. Spiked millet	Both, mixed food.
Sesamum	Cotton	Saves ground.

split, are used by everyone. "Urd" and "mung" are much alike and are usually classed together. They are the best liked of all the pulses. "Moth" is the least used. Some do not care for it, while others keep a small store of it on hand as a special food for invalids. These three, "urd," "mung" and "moth," are dried and split, like the pigeon pea. Bengal gram is one of the most welcome of the products of the spring harvest. In the fields, around the home fire-place, and at the grain-parchers, it supersedes all other parchable foods. Travellers carry it parched, often their sole food. In the Indian army it has been adopted as emergency rations. A few pulses, like the field pea and the cluster bean, can be used green for a short period. But as soon as the peas are ripe they are treated like the other pulses—split and dried. When split, this whole group of pulses is known as "dal," an important division of any family's diet.

Vegetable crops are traditionally in the hands of vegetable growers, Kachhis. The task of growing them is not so much an exclusive privilege as a laborious caste duty. We have been interested in the slight increase in vegetables grown by ordinary farmers during our years in the village. They have discovered that enough water spills over the edge of the big leather water bags to keep vegetables alive on a small patch of ground surrounding an irrigation well. Beyond this they have neither the patience nor the interest to struggle with vegetables, especially in the hot weather when it seems as though nothing green can possibly survive. They leave vegetable growing to the Kachhis. The vine crop is the largest vegetable crop in the village. It includes several kinds of cucumbers and melons which were new to us. Like other foreigners in India, we found the hot season made almost unbearable by the absence of fresh vegetables, until our Indian friends introduced us to several unattractive forms of cucumber, melon and gourd, and showed us how appetizing they could be made with the help of green mangoes and spices.

Tubers and roots are depended upon for winter vegetables. Potatoes are dug and used when very small, chiefly because the crop is in danger of being stolen, or of being destroyed by porcupines. Radishes and carrots, on the other hand, are allowed to grow very large. In his Agriculture of the United Provinces (p. 222), W. H. Moreland reports "Radishes are grown for their bulk, and may be anything up to a foot in length." Of carrots he writes, "The Indian carrot is different from that which is familiar to Europeans as a vegetable; the root is dark coloured and is coarse and flavourless." Beets and tomatoes are grown on a small scale in the vicinity of Mainpuri, but Karimpur conservatism bars them from its fields. The prejudice is chiefly against their colour which is that of blood. Onions are limited in their growing and use to the lower castes. In the Laws of Manu, V. 19, it is written "A twice-born man who knowingly eats murshrooms, a village pig, garlic, a village cock, onions or leeks, will become an outcaste."

There appear, in the village list of vegetables, foods which we overlook. Buds of certain trees are treated as vegetables. And a whole series of leaves, some wild and others incidental to the growing of some field crop, are utilized. Among the former is the white goose foot, and among the latter are radish tops, the leaves of

the Egyptian arum, and the tender tips of pulse and mustard plants. All of these leafy foods are set apart from other vegetable foods, and cooked in a special way. In the village they are called "sag," or greens.

The village looks to its trees as a special source of variety in the diet. And the trees have something to offer during most of the year. Some of the fruits, like the neem and peepal berries, we would never consider as human food, and in government publications they are listed as famine foods. But the children eat them in large quantities and farmers munch them on their way to or from the fields. The children also gather and eat the blossoms of the mahwa tree, and forage for wild plums. Their enjoyment of plums, as well as of other fruits, when hard and green, is amazing. Anyone who has tried to eat a tamarind pod knows how painfully sour it is. We use it to make a hot season drink. But the village youngsters chew one after another without a blink. The tamarind is valued in Sanskrit medicine for its antiscorbutic effect. Certain fruits are so rare that only a few can have them, even for a limited season. Among these are the pomegranate, custard apple, guava, date and lime. Bananas are somewhat less rare, but are treated as a luxury. They are sliced green, skin and all, and cooked with vegetables. Muskmelons and water-melons appear when most welcome, in the hot, dry weather. Everyone manages to get a share of both.

The most popular and the most abundant of all the fruits is the mango. In the hot months, when the ground is baked hard and few growing things survive, the mango trees yield their crop. Mangoes seldom ripen. Wind storms bring down some of the fruit. And the rest comes down, with the help of sticks and stones and secret trips up the trees, before we think it ready to eat. It is the right of everyone in the village to have a share of the mangoes. This is in accord with the Laws of Manu (VIII, 339). "The taking of roots and of fruit from trees. . . . Manu has declared (to be) no theft." The owners of groves do not object to the stripping of their trees, as long as the trees are not damaged, and as long as the fruit is reasonably distributed within the village without being sold. If mangoes were picked and sold, even by the owner of a grove, the village would deal with the offender by its own unique method, that of non-co-operation. We have known progressive landlords who have raised mangoes for sale, but they have been powerful enough to assert their rights. In our village, the old custom prevails to the extent that owners of groves entertain no thought of financial profit. One man, of farmer caste, owns an unfenced grove of 25 old trees, bearing in a good season over 50,000 mangoes Our office clerk lived in the home of this farmer, and was in a position to observe closely. No mangoes were brought into the owner's house from his own grove, during the clerk's two year's stay with him. Fruit from nearby trees, belonging to others, met the needs of his family. He was following the practice of his forefathers in letting others enjoy the fruit from his trees. And he is assured that as they were blessed by the religious merit thus acquired, so will he be blessed, especially since a number of those who eat his mangoes are twice-born. The Government encourages the preservation of groves by not taxing them as

long as they remain groves. Rule 4, Chapter I of the Wajib-ul-arz (Customary Law) states that, "If the trees of a garden are cut down and new trees are not replaced, the Government will have a right to assess land revenue according to circle rates, if that grove has been exempted from the assessment of land revenue at the time of the current settlement." This has helped retain the groves which existed before the last settlement. But there has been almost no effort to plant new groves. The custom of free distribution of fruit fitted into the old regime of simple, personal exchange. Under the comparatively recent system of money exchange, men want some assurance of a money return, before taking the trouble to plant and foster young trees. The following table gives a picture of the sources of the village supply of cultivated fruits.

Number and kinds of trees found in groves of Karimpur

Name of tree	Number mature trees	Number immature
Mango	159	187
Tamarind	1	4
Neem	219	1,051
Peepul	12	8
Gular (wild fig)	5	37
Bel	36	66
Wood-apple	5	27
Indan jujube	46	132
Jaman (kind of plum)	45	63
Khajur (kind of date)	9	76
Khata labhera (plum)	24	55
Heens	..	17
Jack fruit	..	9
Chuara (kind of date)	..	9
Pomegranate	5	2
Guava	50	25
Plantain	18	..
Lime	3	5
Mahua	12	3
Rai labhera (kind of plum)	..	1
Banyan	1	2

Number and kind of trees on the village site

Name of tree	Number
Mango	1
Tamarind	10
Peepul	3
Ber (Indian jujube)	8
Jaman	3
Khata labhera (plum)	2
Anar (pomegranate)	1
Amrud (guava)	2
Banyan	3
Bel	1

The ponds near the village contribute a share of the food supply. Vegetable growers and water-bearers collect generous quantities of water chestnuts and seeds of phapola, a water vine, from nearby ponds, and sell or exchange them at such a low rate that everyone can buy. The phapola, puffed, or popped, was one of our happiest discoveries among village foods. We like it better than popped corn.

At the festival known as Deotan, in November, everyone in the village is allowed a taste of sugarcane, even though it is not ready for cutting. From this time on, one meets children and men chewing and sucking stalks of cane. A stalk may be broken off as one passes by a field, without offence. Not much fresh cane reaches the women shut in the courtyards. But they enjoy whatever the children remember to bring home to them. The fresh juice adds variety to a number of dishes during the pressing season. And the raw sugar, made by boiling down the juice and pressing it down into large cakes, supplies the village with sweetening for the year.

C—ANIMAL PRODUCTS

Animals are a minor source of food supply in a vegetarian community like Karimpur. Cows are kept and milked, but the milk is seldom used as such. Boiled, churned into butter, and clarified, it supplies the pure fat for deep fried foods. Beef is never eaten. Goat meat is eaten about twice a month by the goldsmiths. And Muhammadans eat it oftener, if they can afford it. The goats kept by the village goatherds are supposedly kept for milk, which is sold in Mainpuri. But occasionally a goat, no longer useful, is sold quietly to a Muhammadan butcher. Any goat meat beyond this comes from Muhammadan communities outside Karimpur.

Fish is not eaten by members of the higher castes. But members of lower castes have a feast of fish, during the few days before the ponds dry up for the hot season. The men who are draining the pond with their reed water-lifting baskets, let it be known when the water is getting too low for further usefulness for irrigation. The word passes swiftly, and on the following morning a crowd of low caste men and children gathers at the edge of the pond. Each one has a big round basket without a bottom. The instant the irrigators announce that they are through, the fishers wade into the shallow water and push their baskets down into the mud bottom. They scoop out any fish they have thus captured, and move forward a few steps where they try again. The fish are small, but they are an annual treat.

The few chickens in the village belong to the sweepers, lowest of the outcastes. No one else would eat their eggs or their flesh. The sweepers, along with the Dhanuks, another group of outcastes, own the swine, which act as village sewage system, and which are the only animals raised with a view to butchering. There are many foods denied these outcaste families, but when a swine grows old or ill and is butchered, the feast is theirs. No caste person would come near enough to interfere.

If a family is small, and can afford to keep a buffalo, there will be "ghi" or clarified butter, for all of the cooking. But in most families the "ghi"* must be supplemented by mustard oil, or sesamum oil. There are several varieties of mustard and rape grown in the fields of Karimpur, usually mixed with grain crops, but harvested separately. Each farmer tries to have his own supply, which he

*Pronounced "ghee".

stores, and has pressed month by month, by the oil presser. The better grades are very satisfactory for deep-fat frying. The poorer grades are bitter. The women who are obliged to use the poorer oil, try to relieve it by adding some of the better. When mustard oil becomes scarce, the sesamum harvest is ready with its fresh oil supply. The sesamum is valued not only for its oil but for its flavour. The seeds, with crude sugar, are made into balls. These are among the most popular sweets in the autumn.

D—SPICES

If one tries eating Indian vegetables with only salt added, and then visits an Indian home where these same vegetables are prepared with spices, he has a new appreciation of the art of spicing. An untempting vegetable can be spiced and cooked in several ways, and scarcely be recognized as coming from the same plant. This ability to use spices properly is even more important where there is no meat or meat stock to supply flavour. The variety of spices used in a village home is limited by purchasing power. Everyone tries to have at least red and black pepper, coriander, asafoetida, and turmeric, along with salt. Other spices are necessary for certain dishes, but may be omitted from ordinary daily cooking. A list of spices sold by a village tradesman follows. Two other tradesmen have smaller stocks of the same things. The list does not include peppermint, which is grown in some of the larger courtyards, or coriander, which is grown in fields with grain crops.

Condiments sold by Mohan Singh, Karimpur

Local name	English name	Botanical name*
Hing	Asafoetida	Ferula alliacea.
Lal mirch	Red pepper	Capsicum frutescens used both green and ripe.
Kali mirch	Black pepper	Piper nigrum. From unsorted berries, with some husks.
Safed mirch	White pepper	Piper nigrum. From sorted berries.
Saunf	Aniseed	Pimpinella anisum.
Kala jira	Small fennel	Nigella sativa.
Safed jira	Caraway	Corum carui.
Haldi	Turmeric	Curcuma longa.
Laung	Clove	Eugenia caryophyllata.
Chhoti elachi	Small cardamom	Ellettaria cardamom, true cardamom.
Bari elachi	Greater cardamom	Amomum subulatum.
Nariyal	Cocoanut	Cocos nucifera.
Ajwain		Caryota copticum.
Sonth	Green ginger root	Zingiber officinale.
Kismis	Raisins	Vintis vinifera
Chiraunji		Buchanania latifolia.
Namak	Salt	
Kala namak	Common salt with sodium carbonate, in sort of fusion.	
Chhoti pipar and bari pipar.	Long as cloves, but thin. Not quite as hot as pepper.	
Har	As thick as cardamom, and a half inch long. Supposed to aid digestion.	

*As in the rest of the paper, the spelling is reproduced here exactly as in the original copy.

E—FOOD COSTS IN KARIMPUR

Food prices given in the accompanying table are rarely paid. Farmers would not have money to buy food at these rates, low as they seem to us. They produce most of their own food, or exchange food which they have stored, for food or services which others have to offer. When the exchange is made, there is a great deal of arguing, and he who is the best barterer gets the best bargain. Either the seller or the buyer produces balance scales. One article to be exchanged, such as cucumbers, is put into one pan, and barley, corn, rice or almost any food is placed in the other. The exchangers agree on how the scales should hang, according to their estimate of the value of each article. The pan of cucumbers should swing far down if wheat is in the other pan. If there are sweet potatoes in the other pan, they should almost balance the cucumbers. With this in mind, one realizes the futility of measuring a farmer's food expenditure in terms of money. At best, it can only give a general idea of comparative values. The figures here given we believe to be as accurate as can be found. They were recorded by our clerk, in the household of farmer caste in which he lived. If we were to list the prices which we were actually paying for the same articles at the same time, our figures would be much higher—twice as high in some cases. A white face always sends prices up.

Prices of foods in Karimpur in 1928

Article	Number of pounds purchased for 1 rupee
Wheat	18
Barley	24
Maize	20
Rice	14
Spiked millet	16
Great millet	17
Gram	30
Urd	16
Mung	16
Moth	10
Pigeon pea	32
Milk	12
Ghi	1.25
Mustard oil	3
Potatoes	50
Lauka (kind of pumpkin)	50
Lauki (kind of gourd)	33
Turayan (kind of gourd)	43
Okra	27
Cauliflower	43
Egg plant	66
Green figs	33
Bitter melon	27
String beans	66
Radishes, with tops	66
Carrots	66
Egyptian arum	43
Khata labhera (blossoms)	25
Khata labhera (green fruit)	43
Cluster bean, with pods	65
Cow pea	65
Field pea	33

Article	Number of pounds purchased for 1 rupee
Onions	43
Cucumber	33
Sweet potatoes	33
Kacheria (kind of melon)	43
Senda (variety of cucumber)	43
Mushroom	43
Mustard tops	65
Fenugreek (green)	43
White goose foot	66
Gram tops	65
Spinach and dill	43
Nori (wild pot-herb)	66
Onion tops	99
Paintiya	66
Lissua (wild pot-herb)	66
Pea vine tops	66
Chaunrai (pot herb)	99
Leaves of Egyptian arum	16
Mangoes	66
Guavas	21
Jaman (kind of plum)	66
Water melon	43
Ber (Indian jujube)	66
Water chestnut	66
Tamarind pods	27
Musk melon	43
Raw sugar	12
Salt	28
Red pepper	3
Black pepper	1
Turmeric	2
Aniseed	5
Coriander	3
Asafoetida	0.2
Cloves	1
Big cardamom	1
Garlic	8
Fenugreek (seeds)	8
Caraway	2

Price of meat

A two-year-old pig, weighing about 75 pounds, was butchered on 10th February, 1928. It was divided into 12 shares plus the head. Each share weighed about 5½ pounds, and cost about $.16. The head weighed more, and was the most desirable part. Cost $.20.

III—FROM FIELD TO SERVING TRAY

A—THE CARE OF FOODS AT HARVEST TIME

At harvest time, all of the able bodied men and boys of the village and some of the low caste women go out to the fields. Some cut their own crops, and some are employed to cut those of others. The men squat in a row at one end of a field and move slowly toward the opposite end, cutting the grain handful by handful with their sickles as they hunch along. They tie the cut stalks into bundles, binding them with tough grass. When a field is finished, they carry the bundles, usually on their heads, to one of the groves beside the village. We camped in one of these groves and used to watch the men coming in, balancing their loads and dropping them on the large pile belonging to the master of the field.

The millets are treated differently. Women of farmer and water-carrier castes walk slowly through the field breaking off the heads of grain and dropping them into large flat baskets which they carry. Later the men cut the stalks. This job can be postponed until more important crops are harvested.

Rice is cut in the usual way, but is not carried to a grove. It is threshed close beside the field where it has grown.

Most of the grains and pulses are threshed by the treading of bullocks on a threshing floor. The threshing floor is simply a circle of ground from which grass and weeds have been scraped. The threshing-floor for rice is prepared beside the rice field. Other threshing-floors are in the groves where the cereal and pulses have been stacked. In our grove there were five and sometimes six threshing-floors being used. On each of them from two to six bullocks were driven round and round day after day. Small boys usually do the driving. A stack of grain about three feet high, covering a threshing-floor with a radius of ten feet, takes three days to be threshed by four bullocks. This varies of course with the activity of the driver. People without bullocks must leave their grain stacked in the grove until some one else's animals are available.

In the threshing, the husks are loosened, and many, but not all, are separated from the kernel. The husks of rice and barley are not loosened, by the treading of bullocks. With these two the threshing simply breaks the kernels from the stalk. The actual husking has to be done later by the women in the courtyards.

Close after the threshing comes the winnowing. The men hold shallow baskets of grain high above their heads, and tilt and jerk them in such a way that the kernels fall to the ground. The chaff is carried away by the breeze. If there is no air stirring, two men stand behind the winnowers and flap a long sheet, thus making a breeze.

Grain to be sold is weighed out and poured into gunny bags, beside the threshing-floor. The two men who keep large store-houses of grain to loan or sell later in the season to village neighbours, measure their grain into sacks and have their hired helpers carry it to their store-houses. A few others keep their surplus in

bags. But most of the products of any harvest—grains, pulses, vegetables, or fruits—are carried home from threshing-floor, grove or field, and poured out on the floor of the courtyard. Whatever remains to be done, is the work of the women.

B—STORAGE AND PRESERVATION OF FOODS

The women shape tall jars of clay which remind one of the tale of Ali Baba. They must have them made and well dried before the harvest. As rapidly as the grain is brought in, they spread it on sheets, on their roped cots, and keep moving the cots so that they may get all of the sun possible within the courtyard. When the grain is thus thoroughly dried, they clean it basket by basket full, and fill the jars with it. Near the base of each jar is a small opening, plugged with rags. Through this, a day's supply of grain can be drawn out.

Pulses to be stored require additional treatment. The women must remove any pods not removed in threshing. Then they soak the pulse over night in water and oil. The quantity of water varies. To five pounds of pigeon peas they add ten pounds of water and three and a half ounces of oil. To five pounds of "mung", "urd", or "moth" they add only four ounces of water and an ounce of oil. After the soaking they dry the pulse in the sun for a day or a day and a half. For this they requisition every cot in the house and every sunny inch of the courtyard. When the pulse is thoroughly dried, they split it in the light stone hand mill described. If a woman does not own such a mill, she tries to borrow one from a neighbour or employer. If she cannot borrow, she pries apart the stones of her flour mill, with a wad of cotton on the top of the pivot, and splits the pulse in it. She may split her whole season's supply immediately after the harvest, or she may take care of enough for three or four months at a time. During the splitting process many husks are loosened. She gets rid of them by winnowing the pulse and sifting it, before storing it in clay jars.

There is heavy work left for the women, in the care of rice and barley. Both of these have been partially threshed by the treading of bullocks. Bullock's hoofs are able to separate the husks from the kernels of some grains, but not those of rice or barley. This task is left for the women. With an iron-bound wooden pestle, a woman husks her rice or her barley in a stone mortar set in her floor. It is tiring, strenuous work, and she prefers to do a small portion at a time, as it is needed.

Where there is a supply of a certain grain to be stored, too small to require a tall jar, it is stored in smaller jars, made and baked by the village potter. These are often found in rope baskets, suspended from beams of the family's store-room, off of the courtyard. Grain kept for seed may be stored in the same way, or hung in the courtyard on a beam protruding beyond the store-room wall, protected by eaves. The village housewife wages continuous battle with the rats and insects which covet her stores, and with the crows which settle on the courtyard wall waiting their chance to swoop down on drying grain.

Drying is not limited to cereals and pulses. Greens, such as the tips of peas and mustard plants, are chopped, and dried on the cots in the sun, and kept in baked clay jars, or in bags improvised from old skirts and shirts. "Mahua" flowers, if not all eaten fresh, are similarly dried. Coriander, the most used of spices, is gathered by the children and dried by their mothers. Mangoes, peeled and dried, are kept in jars to be used later to flavour insipid dishes. Mustard seed is dried and stored, ready to be doled out to the oil-presser when a fresh supply of oil is needed.

The only other forms of preservation within the reach of a village housewife are spicing, preserving in oil,, and preserving in salt. Vinegar is not used. The containers in each case are clay jars of various sizes, made by the village potter. Carrots and radishes will keep about a week, if well mixed with spices and covered with oil. The "rai labhera" (small plums) keep longer. And horse-radish, limes and mangoes keep for months. The "rai labhera" and limes are scarce, and hence available to only a few. They require a little oil, and spice. The horse-radish and mango are within every one's reach. Mangoes lend themselves to the greatest variety of preserves. In salt they are acceptable, in spices and oil they are a happy addition to a noon day meal, and in raw sugar they are a special treat.

With clay jars or old cloths as her only containers, and a stifling room as her only storing space, there it little more that the village woman can aspire to, in carrying foods beyond their season.

C—EQUIPMENT

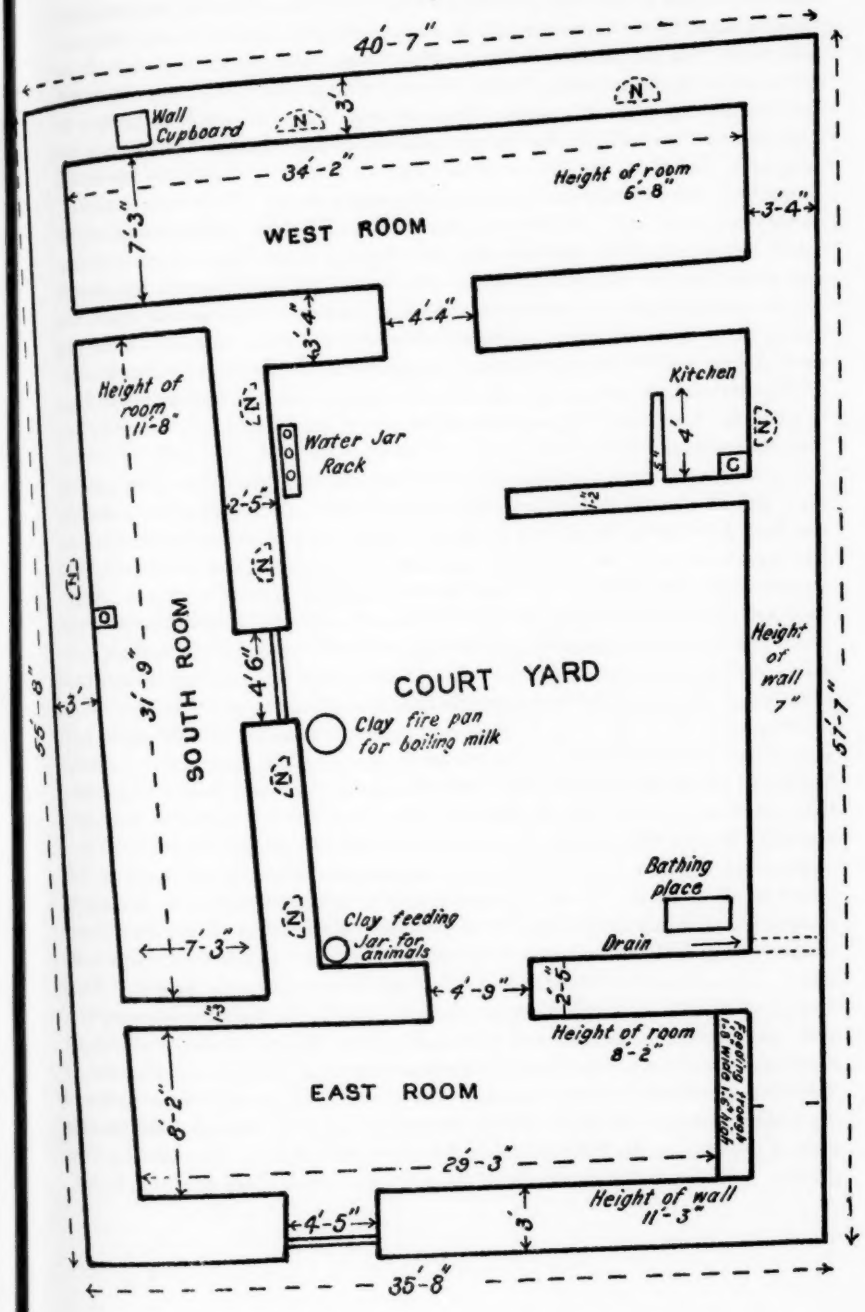
Before considering the further processes through which the food materials must go in the home, it will be necessary to study the equipment with which a village woman works. Her work-room is the courtyard in which all family activities are carried on. The earth is her floor, and the sky is her ceiling. From the courtyard she sees only these and the walls of mud around her.

The walls which surround her are made of mud dug from the bottom of a near-by pond. She cannot see over the tops of the walls and, more important still, no one can look over the walls at her. If she is a Brahman, her courtyard will be large enough for her to work in, and to spread out her grain comfortably, with plenty of sunshine most of the year, and at least a patch of it crossing the floor in mid-winter. If she is an outcaste, her courtyard will be small, originally high, but her walls will be eroded until low enough to admit abundant sun and air. The women who suffer are those whose courtyards are small, and whose husbands insist upon keeping them in strict seclusion. Such a one is the oil-presser's wife, whose courtyard is cramped, and high-walled. During the rains, she works in puddles, and during the winter she shivers between damp walls which shut out the sun. She and her children are among the most wretched in the village.

The carpenters are as near average as any group in the village; and a diagram of a carpenter's house is shown on opposite [page]. The enclosure is a typical in that it has two rooms off the courtyard. Usually only Brahmans have two, whereas those

GROUND PLAN OF A KARIMPUR ENCLOSURE

8 Feet = 1 Inch



less than Brahmans should be content with one. In this particular case the second room was added to accommodate extra brothers. It is now falling into disrepair.

The doors of the courtyard lead to store-room or cattle-room, not to the outside world. On rare occasions when a village woman is going to her father's home for a visit or to the wedding of a relative, she swathes herself in a coarse sheet and goes out through the cattle-room. Her only other means of exit is by ladder. If her courtyard has a ladder, she climbs to the top of her wall and looks over at her neighbour, and if no men are at home in her own or her neighbour's house, she drops down into her neighbour's courtyard for a hasty visit. Aside from these rare breaks, she spends her life in her own courtyard, with food-preparation as her chief task. Her children wear few garments, and these are made by the village seamster, and washed by the village washerman. She has no furniture to care for beyond the unvarnished roped cots, used as beds by night and as drying-racks by day.

During the winter weeks, coverings of home spun sheets or padded quilts are used. These she throws over wooden pegs projecting from the courtyard wall. She has no hangings or rugs, or silver or china to care for. If food processes were as simplified for her as they are for us, her life would be easy. But as it is, her work is heavy and slow.

Her activities centre around her "chulha" (fireplace). Generations ago a great-grandmother-in-law made it in a secluded corner of the courtyard and each daughter-in-law since has kept it in repair. There is a supplementary "chulha" in the store-room to be used in stormy weather, but the one in the courtyard is the true family hearth. It is made of mud piled up and shaped so as to protect a small flame and to support a cooking utensil. (The daily care which the housewife gives her "chulha" will be discussed in connexion with the ceremonies of cooking and eating.) Her fuel is the twigs which the children gather from groves, or the dung cakes which she and other women of the household have shaped.

Almost as necessary as her fireplace is her stone flour-mill. All the grains and pulses which are to be made into bread must be ground in the home mill. The mill is made of two stones, cut like discs about two inches thick and from one and one-half to two and one-half feet in diameter. The housewife has embedded the lower stone in a base of clay, which lifts it to a convenient height from the floor. The upper stone is free to turn on the lower one, being held in place by a peg in the centre of the lower stone which passes through a hole in the centre of the upper stone. The clay base has a diameter several inches greater than that of the stones, so that it forms a border around the outside of the mill. This is trenched to look like a moat surrounding a low stone castle. As the woman turns the upper stone round and round with a wooden peg fitted into a slot near the rim, she pours her grain into the hole at the centre of the stone. As the grain is crushed and ground between the stones it gradually spills out around the edges into the encircling moat. When the grinding is finished, the housewife brushes the flour out into a winnowing basket, and separates chaff and clay-dust from the ground grain. She returns some of the bran to the flour, unless the bread is intended for a special feast. The grinding is heavy, tedious work, and if possible two women share it, sitting facing

each other across the mill, each with a hand on the turning peg. One of them pours the grain into the centre hole, without breaking the rhythm of the turning. The steady hum of the grinding stone is one of the earliest morning sounds of the village. In a few homes one finds a "darenti", a mill patterned after the one described, but smaller and lighter. It is used in splitting the pulses. As the supply for several months can be food. For the winnowing and sifting there are baskets and sieves. Cooking utensils are never borrowed, but the "darenti" is regarded differently, although it touches the food.

Before rice or barley can be ground they must be husked. For this the housewife has a pestle and mortar. The pestle is a thick pole about four feet long, bound with iron rings, one of which forms a rim at the bottom. The mortar is a stone cup set into the earth floor of the courtyard. The husking is another strenuous task usually shared by two women. They sit on the floor one on either side of the mortar. Each woman holds a pestle, and turn by turn, each lifts her pestle above her head and brings it down heavily into the rice, some of which is struck, but much of which flies out of the mortar. One of the women keeps brushing the scattered grains back into the mortar, while managing to keep her hand out of the way of the pestles, and not missing her turn. The grain thus treated is not only husked but chipped and broken. However, skilful winnowing saves every scrap that might [be] food. For the winnowing and sifting there are baskets and sieves of several sizes and shapes. The winnowing baskets are of reeds. The sieves may be strung with coarse threads or reeds.

The utensils which the village housewife uses are made of brass, iron, stone, clay or wood. When she makes her daily bread (she actually does make it every day), she may mix and knead her dough in a bowl of brass or wood, or baked clay. She pats out the flat round cakes with her hands if the flour comes from mixtures of corn, barley, millets or pulses. If the cakes are of wheat, and especially if they are intended for guests, she rolls them out thin on her small round breadboard, which is of stone rather than wood if she can afford it. To bake her bread, she may rest over her fire a convex iron plate which she brushes with clay, to keep the cakes from sticking. Or she may fry the cakes in deep fat in an iron vessel shaped very much like those which we use for deep-fat frying. She lifts the cakes out of the fat with a long-handled, flat-bowled iron spoon, which may or may not be perforated. And when her bread is ready and her husband calls for it she serves it on a brass tray, always brightly polished. For cleaning her brass she rubs loose a bit of her earth floor, applies it with a knot of grass and much rubbing, and rinses it off.

When she prepares vegetables she rarely removes the skins, but cuts up the whole vegetable with a small sickle. She braces the handle under her toes so that the blade stands upright. Against this she pushes the vegetable. Greens are held in bundles and cut through in the same way. To fry her vegetable, she uses the same iron pan for deep-frying. To boil her "greens" (leaves and herbs), she uses a brass kettle with straight sides and no handles. Both "greens" and vegetables

she serves on the brass tray with the bread. The bread is broken off bit by bit and used to dip up the other food. If she is serving guests, she will place bread and vegetables and any other food on clay saucers or dishes made of large leaves bound together with twigs. These can be thrown away when the guests depart. In no case should household utensils or dishes be touched by others than members of the family. When I admire a piece of brass, I always admire from afar.

Every day the housewife grinds the spices to be used in the food. For this she has a stone about an inch thick, about six inches wide and a foot or more long, curving gracefully to a point at one end. On its corrugated surface she lays her spices, sprinkles them with water, then rolls a small, rough stone roller back and forth over them until they form a paste.

Every morning and evening she puts fresh milk on to simmer. For this she uses a baked clay jar, set in a smouldering fire of dung cakes. A separate fire-arrangement is required for this long period cooking. It consists of a large, shallow basin with a thick base which she has made of clay. In it she places a burning dung cake, with others arranged over and around it, like a nest for the jar of milk. After hours of simmering she pours the scalded milk from this clay jar into another kept for the purpose. And the next morning she pours the clabbered milk into still another clay jar which serves as a churn. Each of these jars has a distinct shape and is called by a different name. The churning paddle is a stick of wood with cross pieces at the bottom. The woman who is to churn loops a rope around the leg of a cot and then twists it at the middle around the paddle, and holds the two ends in her two hands. By pulling one end of the rope and then the other, she rotates the paddle horizontally and keeps it rotating until butter forms. The churned butter is placed in a special jar with other butter and accumulated for a week, at which time it is clarified.

The utensils mentioned, along with the large clay jars which are filled each day with water, our housewife considers necessary to the feeding of her family. With increasing means and increasing family, she may add to the number of these same articles, or she may replace clay with iron, or iron and wood with brass. Or she may add brass cooking utensils and serving dishes of varied sizes and shapes. She may aspire to a serving dish or cup of bell metal, which is more expensive than brass. Beyond this, her desires do not go.

The following list of utensils indicates the variety used, and the relative importance of the different articles, as shown by their frequency. The list includes forty-eight households which represent all castes and all degrees of prosperity. I have divided them roughly into what our village friends call "rich", "moderate", and "poor". They would add to the list "very poor", but these I have included under "poor". There is no way of estimating the actual wealth of a family. Those who appear poor are very apt to have money and jewellery hidden away in a wall or the ground. Indebtedness is no register, as most of the village is in debt:

List of articles, with percentage of rich, moderate, and poor homes, in which each occurs

Local name	Description	Classification of homes		
		5 rich	22 moderate	21 poor
		Per cent.	Per cent.	Per cent.
Chakki	Grinding stone	100	100	86
Darenti	Light mill for splitting pulses	60	24	5
Musal	Pole-pestle for husking rice	100	100	100
Dahkli	Stone mortar for rice	100	100	100
Charpai	Roped cot on which foods are dried.	100	100	100
Chalni	Round wooden sieves strung with thread.	100	100	95
Sup	Reed winnowing basket	100	100	100
Parat	Brass mixing bowl	80	50	14
Tasla	Iron mixing bowl	80	32	. .
Kanthani	Wood mixing bowl	100	64	62
Katheli	Smaller wood mixing bowl	100	73	67
Kunra	Clay mixing bowl	80	5	. .
Kunri	Smaller mixing bowl	100	55	24
Pata (w)	Wooden rolling board	100	100	95
Pata (s)	Stone rolling board	80	41	33
Belan	Wooden rolling pin	100	85	95
Tawa	Convex iron griddle	100	100	100
Karahiya	Iron pan for deep fat frying	100	91	86
Hansiya	Small sickle for cutting vegetables	100	95	86
Sil batta	Stone on which spices are ground	100	100	100
Lorhwa	Roller for grinding spices	100	100	100
Batua	Brass kettle for boiling greens	100	77	52
Patili	Small cooking pot	80	45	24
Mathni	Churn	80	77	38
Chamcha	Long handled iron spoon	100	100	90
Kalcha	Different type of iron spoon	100	100	100
Chamcha (wood)	Wooden spoon	. .	. .	19
Chimta	Iron fire tongs	100	86	57
Chimti	Smaller iron tongs	20	9	. .
Sansi	Tongs curved for lifting kettles	80	9	. .
Thara	Clay water jar	100	100	100
Kalsa	Brass water jar	100	59	. .
Chilamchi	Brass wash basin	20	. .	. .
Silafchi	Brass basin	20	. .	. .
Thali	Brass serving tray	100	95	86
Phul Thali	Tray of bell metal	80	45	5
Rakabi	Brass plate	80	18	. .
Lota	Brass drinking bowl	100	100	62
Phul lota	Drinking bowl of bell metal	40	. .	. .
Bela	Brass cup in which food may be served.	100	100	86
Phul bella	Bell metal cup	60	27	9
Gilas	Brass glass	100	86	67
Ghanti	Small brass water vessel	80	68	81
Tarazu	Balance scales	100	95	76
Pandan	Box containing betel condiments	60	9	5
Clay saucers	Cups and jars	100	100	100

D—DISHES PREPARED FROM—

Cereals

Every day the village woman makes fresh bread for her family. As has been mentioned, she makes it of wheat, barley, or mixtures of these with pulses, from the spring harvest until the end of the rainy season. From the end of the rains until spring, she makes it of maize, different millets, and perhaps rice, with a wheat mixture occasionally as a treat.

Whatever the grain, she suns it well the day before she uses it. Early on the day when she is to bake it into bread, she, with the help of another woman of the family, grinds and winnows it. She mixes the flour with water in her mixing bowl and kneads it by alternately working it vigorously with both hands, and pounding it with her knuckles. When she considers it "soft enough," she takes up a ball of the dough and works it further in her hands, before patting and rotating it into a round, flat cake. While she turns the cake in her hands, she pinches the edges. She brushes a daub of wet clay over her thin, convex griddle, to keep the cakes from sticking. As each cake is shaped, she flops it on to the griddle. There is only room for one cake at a time. She turns it over with her long, flat iron spoon. While the first cake cooks, she shapes the second. As soon as the first is done well on one side, and slightly on the other, she stands it upright inside the fireplace under the griddle, to toast, while the second cake cooks above, and she shapes a third. Meanwhile, she must keep her fire alive by blowing it and adding fresh fuel. Her fuel may be small twigs, gathered by the children, or dung which she has gathered in her stable, or which the children have collected in fields or on roads, and which she has mixed with chaff and water and shaped into cakes of convenient size for her fireplace. The bread which toasts close besides the fire, must be watched lest the burning fuel touch it, or lest it topple over into the flame. If its edges have been pressed together properly, the cake swells out like a balloon, as the moisture inside turns to steam. At this point, the cook lifts it out with her iron fire tongs, and bangs it against anything convenient to drive out the expanded air. The steps in bread making are listed on page 335.

The women prefer wheat, or mixtures in which wheat appears, not only because of the better flavour, but because wheat flour is more satisfactory to work with. When making wheaten cakes, the housewife can roll them out with her small rolling-pin, after patting them between her hands. Cakes of other grains fall apart if she tries to make them equally thin. Corn cakes are a cross between corn-meal mush, and corn bread. Cakes of the little millet look like clay, before they are baked. They are mealy and have a raw taste. Cakes of sorgum are brown with a purplish tint, and are slightly bitter, and mealy. Cakes of Italian and of Poorman's millet are still less desirable. Wheat is always used for bread which is to be fried in deep fat. When fried, the bread is known as "puri" as distinguished from the toasted bread which is "chapati". Both "puris" and "chapatis" are

covered by the general term "roti". The occasions on which "puris" are required are discussed under the ceremonial significance of food.

Parched grains provide a useful variation in village fare. The grain-parcher is kept busy most of the day when a fresh crop of grain is cut. At other times he keeps his furnace going late each afternoon. The farmer or one of his children brings the grain to be parched. The parcher has a clay furnace in which he burns leaves and twigs. In the furnace he heats clay jars of sand. He mixes the grain with the hot sand and keeps mixing them until the grain has popped or puffed, or browned. Then he sifts out the sand, and gives the grain back to the farmer, after taking out a portion as his pay. The grain thus roasted may be eaten as it is. Or the farmer's wife may grind it coarsely for his morning meal. If there is buttermilk, it is added to the ground, parched grain. If not, water is added, and a little raw sugar, if there is any. If not, there is always salt. The daily ceremonies which must precede any cooking make it impossible to prepare an early cooked breakfast. This ground, parched grain, called "satua," solves the breakfast problem for the farmer, and perhaps for the children. The women and children usually eat cold food left from the day before, but the men scorn this.

If the grain to be parched or roasted for "satua" is fresh, it goes straight to the parcher. But if it is dry—as it is most of the year—the farmer's wife must soak it for twelve hours, and sun it for six hours before her husband carries it to the parcher. Corn, barley, or a combination of barley and gram or of barley and peas, are the most popular. A quantity is sent to the parcher that will supply the family with "satua" for several weeks, or perhaps, months. A prosperous farmer may carry a maund and a half (about one hundred and twenty pounds) to the parcher's, while his poorer neighbour carries about ten pounds. And each hopes to have "satua" enough to feed himself for the same period. When the parched grain is brought home, the women pound it in the stone mortar set in the courtyard floor. This loosens the outer skins. Then they clean it, and grind a week's supply at a time.

At harvest time there is a feast of parched foods in which the parcher has no share. While men rest from harvesting in the fields, or while they sit with their brotherhood after a strenuous day's work, they gather a pile of leaves or stalks and scatter the heads of green grain or the pods of legumes within the pile. They light it from a scrap of smouldering cow-dung, always on hand for lighting pipes. When the blaze dies down, they scatter the charred remains and pick out the smoking heads of grain. These they rub between their palms until the kernels are freed. Some are still green; others are charred black. But the combination is very agreeable. The women and children manage to get a share of the heads for roasting, from the stalks which the men bring home at the close of each day's work in the harvest fields. Peas, wheat, and barley are thus treated and eaten in March and early April. During the harvest at the end of the rains, the heads of both large and small millets are laid on the fire, and the green ears of corn are husked and turned in a blaze or in the embers of a fire of twigs. The corn is field and not

sweet corn, but it is good roasted. These popular products are available to everyone in the village, for at these seasons every able man has a chance to help some farmer. And those who cannot, plan to be present when generous neighbours indulge. The amount of parching done in the fields depends on the good will of the owner of the field. If he is miserly, or work is pressing, he may allow little time for rest and feasting. But ordinarily, it is an accepted part of the day's routine.

Other dishes in which cereals appear, are prepared for certain festivals. These come so seldom that the foods are not of great significance from the point of view of nutrition. In the eyes of the village housewife they are tremendously important and consume much of her conversation and time. They are at the end of this chapter, along with other festive dishes.

Rice is treated differently from the usual cereals. For bread it must be husked with mortar and pestle, then ground. It makes a very soft dough. The cook keeps her hands moist while handling it. It is toasted like any other bread. Rice is used for bread only when there are no other grains on hand.

It is more often used in "khichri." Water is boiled in a brass kettle, and rice and a split pulse are dropped in together and cooked. They may be in equal proportions, or there may be less pulse.

A variation of this with a decidedly different flavour and "feel" is "dal bhat." The rice and split pulse are cooked separately and combined when almost dry. The women of the family drink the rice-water.

Sometimes rice is soaked and later fried in "ghi" (clarified butter) and salted. Oil may not be used for this. "Khir" is a dish which is limited to households where there is enough milk so that all is not needed for "ghi." Rice is boiled in milk and sweetened (one-half pound rice to about three quarts milk). Villagers say that there should be as much raw sugar added as there is rice. Just before serving, a little "ghi" should be added.

A variation of this dish, which is available to a much larger number, is "Raskhir." The juice of the sugarcane is boiled, and rice cooked in it. It has a flavour which we think disagreeably strong, but village folk eat quantities of it with pleasure. A cross between these two, is a dish called "maheri," in which buttermilk and raw sugar are added to cooked rice.

We can get puffed rice in the market town during most of the year. But in the village it only appears at the time of the festival of lights, in the autumn. Then the grain parcher buys the better variety of rice necessary and puffs it in his hot sand. Everyone in the village comes to him to get some. Other occasional uses of rice will be described under special dishes.

STEPS IN MAKING TOASTED BREAD

Maize

Process	Time consumed	Weight before	Weight after
Bringing dung from drying pile and bringing water.	20 minutes.		
Pounding with pestle	3 minutes . .	3 lb. . .	3 lb.
Winnowing, to remove insects, husks, etc.	2 minutes . .	3 lb. . .	2 lb. 13 oz.
Grinding	1 hr. 5 min.	2 lb. 13 oz.	2 lb. 9 oz.
Sifting	2 minutes . .	2 lb. 9 oz.	2 lb. 8 oz.
Making into cakes	45 minutes	Water+2 lb. 8 oz.	4 lb. 3 oz.

Wheat

Pounding with pestle and winnowing to remove insects, husks, etc.	30 minutes.	3 lb. . .	2 lb. 12 oz.
Grinding	1 hour . .	2 lb. 12 oz.	2 lb. 10 oz.
Sifting	3 minutes.	2 lb. 10 oz.	2 lb. 9 oz.
Kneading, rolling, cooking	. .	Water+2 lb. 9 oz.	4 lb.

Number of cakes made from one pound of grain

	Cakes
Maize	3
Wheat	7
Large millet (sorgum)	7
Small millet	6
Tirra (wheat, barley, gram)	6
Gojai (wheat and barley)	7
Rice	7
Barley	8
Bejai (barley and peas)	8
Wheat—grain	8
Wheat (cakes fried in deep fat)	10

⅔c. clarified butter. ⅓c. left after frying.

Pulses

When we visit in a village home, our host always asks hospitably if we have had our "dal roti" (split pulse and bread), which is his idea of a satisfactory meal. The term "dal" is applied primarily to the dish of cooked legumes served with bread. It also applies to any of the pulses, after they have passed through the splitting process and are like split peas. Before this stage there is no inclusive class name, and each pulse is known by its plant title. If turned to some purpose before being split, a special descriptive term is used for the particular product. For instance, split peas may be referred to simply as "dal". If cooked green, they are "matar ki tarkari" (peas as vegetables) or if toasted they are "matar ka chabena". When a man goes to buy "dal", he must then designate from what plant the desired "dal" comes, and his wife in taking "dal" out of storage for some particular dish, is careful to select the split product appropriate for her purpose. For the

ordinary "dal" to be cooked and eaten with bread, she has no choice beyond the supply on hand or her husband's digestive powers. The uses of the pulses, before and after they are split, are outlined at the end of this section.

When "dal" is to be served, the housewife gets out the desired amount the day before. If she has "mung", "urd" or "moth" she pounds it with her pestle, then soaks it overnight. By morning she can rub off the loosened husks under water and skim them from the top. She does not throw the husks away, but saves them and combines them with barley and wheat in making bread. If she is in a hurry, she may omit the soaking and let the family eat husks along with the pulse. Field peas do not require soaking, as husks come off during the splitting. She heats water (about two quarts to a pound of "dal") and while it is heating, she prepares her spices. She grinds red pepper and half a root of turmeric on her spice-stone, and adds them to the boiling water. Then she adds the "dal" and salt (one teaspoonful), and cooks it until it is pulpy when rubbed between the fingers (about thirty minutes). When it is almost done, she grinds coriander (about twenty seeds) and adds it to the "dal". If she has cinnamon, cloves and cardamom, she adds them as well. To improve the flavour further, she may put a teaspoonful of clarified butter on the tip of the big iron spoon, and drop a few chips of asafoetida into it. She heats this until it sizzles, then stirs it into the "dal" and covers it quickly with a wooden lid. Our village friends assure us that the asafoetida prevents flatulence.

The "dal" is quite soupy, but any one brought up in the village knows how to eat it efficiently, if not noiselessly, by dipping it up with pieces of bread. We like the flavour of all the "dals," but "mung", "urd", and pigeon pea have a slippery feeling which is unpleasant. Cooking the husks with the pulse, relieves this somewhat. Field peas may be cooked as these other "dals", making a more appetizing dish, at least for us.

Certain "dal" dishes remind one of meat substitutes, although to the villagers, meat is our "dal" substitute. One such dish is "mungauri" in "jhori". To make this, the farmer's wife takes one pound of "mung" from her store, and soaks it to loosen the skins. She rubs it between her hands and washes it until the pulse is clean. She then grinds it on her spice-stone, handful by handful, until it is a paste. To this mushy product she adds a teaspoon of salt. Into her pan for deep-frying she pours ⅓ cup of mustard oil or "ghi" (clarified butter). If it is mustard oil, she heats it until it becomes clear and the odour is gone. Then she drops the "mung" into the hot oil or "ghi". She does this by taking up a handful and shoving off a bit at a time with her thumb. It forms irregular lumps about three-fourth inches in diameter, which she removes from the hot fat when brown. These may be eaten as they are, but should be served in "jhori". She makes the "jhori" by adding water to more "dal" paste and frying the mixture in a tablespoonful of "ghi". For flavour she adds a few seeds of "methi" (fenugreek). She stirs it occasionally, but does not scrape loose that which sticks to the pan. She then adds turmeric and salt to taste, and still later adds coriander, black and red pepper, one

cardamom, three cloves and a small stick of cinnamon, all ground together. At first this "jhori" is an unappetizing, brown soup somewhat lumpy. The spices turn it to a lighter brown and further cooking makes it a thick gravy. When it is done, the fried cakes of "mungauri" are dropped into it. The product is very much like hamburg cakes in gravy. These same cakes, "mungauri", can be cooked with spiced potatoes, in which case it seems still more like a meat dish.

"Mithori ka jhor" is a similar dish. When a woman makes it, she cleans her "mung", then grinds it like flour with her heavy grinding stone. She adds a touch of asafoetida and red pepper, and makes it into a thin batter. This she drops bit by bit into a kettle of boiling water. As soon as the little cakes or lumps are firm, she takes them out and dries them on a roped cot in the sun. She can put them away and use them from time to time to vary her pulse dishes. When she wishes to serve them she browns them in oil or "ghi", and adds buttermilk, thickened with a flour of gram—one-fourth pound of flour to two-thirds quart of buttermilk.

Still another dish on the meat-cake order is made by preparing and frying small flat cakes of gram flour, and adding buttermilk. The cakes are "danre" and the gravy "karhi". It tastes rather sour, an unfamiliar flavour to us in gravy. It should be eaten with rice or bread of some wheat mixture. The "danre" of gram, is crumbly, whereas the "mungauri" made of "mung" is slightly tough.

Pulses may be combined with cereals in bread. They make a stickier dough which is harder to handle than a dough of wheat or corn. They also add a distinct flavour of partially cooked peas. A favourite village dish is a wheat cake with pulse filling. To make these cakes the housewife makes a dough of wheat flour as for bread, but adds more water to make it softer. To one pound of wheat flour, she makes a filling of six ounces of "urd", soaked and cleaned and rubbed on her spice stone to a paste. She spices it with red pepper, three cloves, a stick of cinnamon, forty coriander seeds, one cardamom and twenty seeds of aniseed, a touch of asafoetida, and a teaspoon of salt. She takes a ball of dough in her hand, flattens it out, lays some of the filling on it and draws up the corners to cover the filling. Then she rolls it out, like a wheat cake, and drops it into hot fat. It puffs and browns, but loses none of its filling if properly prepared. When finished it makes seventeen cakes, weighing two pounds. When eaten hot, these filled cakes are delicious. The difficulty with most of these pulse dishes is that they should be prepared immediately before serving. This is one reason why village feasts are always several hours late.

Although pulses are used chiefly as "dal", dried and split, they make a distinct contribution before reaching this stage. The tender tips of the growing plants of field peas are cooked as greens, or they may be cooked with potatoes as a regular vegetable dish. Small potatoes are cut in half and browned in "ghi", which is flavoured with asafoetida. A little water is added, along with salt, red and black pepper, cloves, coriander, and cardamom. The pea tops are added and the whole is cooked until the potatoes are tender. Green pea pods may be cooked with potatoes in the same way.

The long pods of the cow pea may serve as a vegetable. If they are green enough, they are cut up with the sickle, browned in a little oil or "ghi" with turmeric, black and red pepper, cloves, cinnamon, cardamom, coriander and salt. Then a little water is added, in which the cut up pods are cooked until tender. At the last a thin paste of gram flour and buttermilk is added. If the pods have begun to dry, they must be removed and the peas cooked without them.

The cluster bean is chopped up and cooked in the same way, but without any addition of buttermilk. Most of the water is boiled away. Both these cluster bean and cow-pea can be dried in their pods and stored, to be used later as a vegetable dish.

Like the cereals, pulses are popular when roasted, or parched. Sometimes they are roasted in their pods while green, but ordinarily they are first shelled and dried. When parched they may be eaten just as they are, like the gram which carries many a traveller through days away from home. Or they may be ground coarsely with parched cereals into "satua" for the farmer's breakfast.

Vegetables

The vegetables which are most abundant are often eaten raw between meals, as we eat fruit. During the carrot season one sees the children, especially in the quarters where vegetable growers live, gnawing at raw carrots while they creep after their mothers or play together in the lanes. The same is true when sweet potatoes are plentiful. The sweet potatoes may be partially roasted in a bonfire built in the lane or on the courtyard floor. And in the hot weather, men, women and children may be seen feasting on long green cucumbers. Roadside vendor stalls and religious fairs abound in cheap cucumbers so that one cannot miss them, at home or abroad.

The vegetables which grow less abundantly are cooked and eaten with bread. When there is a vegetable dish, the pulse is usually omitted, unless there is great prosperity in the home, or a guest. Practically the same plan is followed in preparing all vegetables. Seeds and other inedible portions are removed. Most skins have been found edible, and remain. Potatoes are never peeled. Neither are plantains. The vegetable is cut up with the small sickle mentioned. Every village girl learns to brace the handle of the sickle firmly with her toes, and press the vegetable against the blade, one hand on either side of the blade.

A tablespoonful or two of "ghi" where there are milch animals, or mustard oil where there are none, is heated with a little fenugreek or in some cases asafoetida, in the pan for deep frying. When the fenugreek is well browned, the chopped vegetable is added, with enough water to keep it from burning. While it cooks spices are added, varying from salt, pepper and coriander in poorer homes, to these plus cloves, cinnamon and cardamom in prosperous families. The yellow-green, spice-coated, oily product is partly mush and partly in lumps. None of the liquid is poured off. It is eaten with the help of torn-off bits of bread. In appearance it may not be appetizing, but it is delicious.

Pulses used in the homes of Karimpur

Pulse	Comparative amounts used	Uses when not split	Preparation of split product—"Dal"		Use of split product—"Dal"
			Processes at time of harvest	Processes at time consumed	
Pigeon pea . .	More than any other as "dal". But less than gram for total uses.	1. Roasted . .	Soaked, dried. Split. Winnowed. Fried further. Stored.	Pounded (mortar and pestle). Winnowed. Cooked.	1. Boiled with spices. 2. Ground. Made into bread, alone, or with wheat and barley, wheat and gram, or gram alone.
Gram . .	Total used is more than other pulses.	1. Green pods, as vegetable. 2. Roasted plain. . . 3. Soaked, fried in "ghi", salt and pepper. Roasted. 4. Roasted. Ground with wheat and barley, or wheat and peas for morning "satua."	Halfsplit. Winnowed. Dried further. Stored. Other half similarly treated in September for remainder of year.	Pounded. Winnowed. Cooked.	1. Boiled with spices. 2. Ground into flour, to be used in special sweets. 3. Ground and made into bread, alone, with pigeon pea, with wheat and barley, or barley.
Field pea . .	Less than gram or chick pea. More than urd, mung, or moth.	1. Tops of plants as greens. 2. Green pods and green peas as vegetables. 3. Dried, used as vegetable. 4. Roasted in pods. 5. Roasted. Ground with barley, or barley and gram for "satua."	Stored unsplit. Later enough for 3 or 4 months split at a time.	Cleaned . .	1. Boiled. Only eaten in this way when other "dals" are gone. 2. Ground, with barley, or wheat and barley, to make bread.

Pulses used in the homes of Karimpur—(continued)

Pulse	Comparative amounts used	Uses when not split	Preparation of split product—"Dal"		Uses of split product —"Dal"
			Processes at time of harvest	Processes at time consumed	
Urd . .	Less grown than peas. More used as "dal."		Rubbed with oil. Split. Stored.	Pounded. Soaked. Husks rubbed off.	1. Boiled with spices. 2. Cooked with rice. 3. Cooked separately and added to rice. 4. Ground with wheat or wheat and barley for bread. 5. Ground for special cakes.
Mung . .	Slightly less than urd.	Roasted and ground for sweet-cakes.	Rubbed with oil. Split. Stored.	Pounded. Soaked. Husks removed.	1. Boiled with spices. 2. Like urd, above. 3. Ditto. 4. Combined with wheat, or barley, or both, and ground for bread. 5. Ground for sweet-cakes. 6. Ground and used in meat-like dishes.
Moth . .	Little . .	1. Roasted. Ground for sweet-cakes. 2. Roasted alone or with maize and ground for morning "satua."	Rubbed with oil. Split. Stored.	Pounded. Soaked. Husks rubbed off.	1. Cooked with spices. Especially for invalids. 2. Mixed with other pulses and millet, and ground for bread. 3. Combined with "mung", in meat-like dishes.
Gram . .	Little used by men. Much used by horses.	1. Cut up fresh. Cooked			

						3. Combined with "mung", in meat-like dishes.
Cluster-bean.	Little used by men. More for animals.	1. Cut up fresh. Cooked as vegetable. 2. Dried. Stored. Soaked. Cooked as vegetable.				
Cow-pea . .	Little . .	1. Cooked fresh. 2. Dried. Stored. Soaked. Cooked as vegetable.				
String beans . .	Small amounts grown by Kachhi vegetable growers.	1. Cut up. Strings removed. Cooked as vegetable, usually with potatoes.				

Potatoes are a popular base for this vegetable dish during the autumn and winter months. And almost any vegetable may be added to them. Egyptian arum, similar to dasheen corms, is available as potatoes decline, and it makes a satisfactory base. The vegetables used in this conventional vegetable dish, either with potato or Egyptian arum, or with each other, or alone, are carrots, radishes (alone or with tops), sweet potatoes, cauliflower, cabbage, egg plant, okra, yam, tops of young pea plants, field peas and cow peas with or without pods, string beans, and cluster beans, and all the varieties of cucumbers and gourds available. Mushrooms are sometimes included. And fruits, such as mangoes, plantains and melons may be used in this way.

"Reota" is a dish in which the village cook combines vegetables and buttermilk. She may make it of white goose-foot, potato, pumpkin or gourd. She boils the potherb or vegetable, then cooks and drains it. She wraps a bit of asafoetida in cotton, and sprinkles oil on it. This she lays in a smouldering dung cake, and over it she inverts the vessel in which the "reota" is to be prepared. This vessel should be of baked clay, to absorb the fumes better. While the asafoetida fumes, she rubs the vegetable on the spice-stone to a paste. Next she uses the stone for the necessary spices—small red pepper, one seed of black pepper, one teaspoonful coriander seeds, one clove, and about three-fourths teaspoonful salt. Then she mixes the spices in with the vegetable, and rubs them all together on the spice-stone. She sets the clay jar upright and pours buttermilk into it, and puts on the wooden lid quickly. Then she scrapes the vegetable and spices into it, and again puts on the lid. She serves it cold. It looks like a mash, and is quite attractive when green vegetable is used. When one becomes accustomed to the flavour, it is very welcome in hot weather.

Similar to "reota" is the vegetable dish in which buttermilk and gram flour are blended and added to green peas or beans which have been cooked until tender. One other successful vegetable dish is made from the leaf of the Egyptian arum. It is not prepared as much by village women as by those in town. The large leaf is opened out and covered with gram flour and spices. Then it is rolled up like a jelly-roll and sliced off as a roll is sliced. The round, filled slices are fried in "ghi" or oil. It is one of the best tasting of vegetables.

The following table (pages 342 and 343) gives the ordinary procedure followed in preparing vegetables. Vegetables representing various classes and various methods of treatment have been chosen. To us, the differences in method are slight, but to the village cook they are very important.

"Achar," which approaches our pickles, is made from carrots, radishes, beans, and horse-radish, and onions, in low caste homes. When a farmer brings in a generous supply of any of those, his wife uses a portion for "achar." She cuts up the vegetable as for the ordinary vegetable dish. She scrapes and washes carrots and onions. She strings the beans and removes the tough fibrous skin of the horse-radish. The last two she cooks. When prepared, cooked or uncooked, she spreads them in the sun to dry. While they dry, she grinds on her rough spicestone: husked mustard seed, coriander, black pepper, red pepper, turmeric, with perhaps cloves

and big cardamom. She grinds these dry, not moistened as she does for the usual vegetable dish. She puts both vegetables and spices in a clay jar and stirs them together well. Last, she adds enough mustard oil to cover the vegetable with a spicy, oily coat. Beans are ready in twenty-four hours. The others she must shake and sun daily for four or five days. They must all be eaten soon after they are ready, as they rapidly ferment.

Greens

Certain vegetables are boiled in water in a deep kettle, without the addition of fat. When prepared in this way they are designated as "sag"—greens. Potherbs, tops of growing pulse or mustard plants, radish tops, leaves of Egyptian arum, dill, and "palak," a leaf resembling our spinach, may all be cooked as "sag." During a few months, fresh green leaves are available. Some of them are dried and stored for later use.

When a village woman plans to cook "sag," she cuts up the leaves by pushing a bundle of them against the upright blade of her sickle, layer by layer. She has learned to cut them very fine in this way, without slicing her fingers with them. She then washes the leaves and cooks them in water in a straight, deep brass kettle. She uses one quart of water to one pound of vegetables. The water is warmed and salted before she adds the vegetables. After it has begun cooking, she adds "dal" or "mung" or "urd" (one-third cup to one pound vegetables). She is careful to add it so that both "dal" and leaves will be finished at the same time. To lend flavour she adds several slices of dried mango. When she is ready to remove the kettle from the fire, she adds a small amount of wheat flour (about one-fourth cup) slowly while stirring. She explains that "without flour the 'sag' will be by itself and the water by itself." The flour binds the whole. As soon as she removes it from the fire she heats a teaspoonful of "ghi" and a broken up clove or a chop of asafoetida, in her iron spoon over the flame. When it is sizzling she plunges it into the "sag" and covers it quickly with a wooden lid.

An old village woman once taught me this song:

> "O daughter-in-law, today I want the leaves, the tender leaves plucked from the tops of young grain in the field.
> Tomorrow it will be fenugreek that I require.
> On Wednesday I myself shall nip the pale mustard tops and you will cook them delicately in oil.
> On the day following a wild potherb will do.
> On Friday still another, much more satisfying to the hungry—the yam—Don't forget.
> And after that, egg plant will follow, stewed and spiced.
> The squash or perhaps the bitter melon, we shall leave for Sunday.
> Always remember, O wife of my son, I have no taste for bitter melons, often."

Fruits

Most of the wild fruits, and berries of the peepul and neem trees are eaten raw, and usually when hard and green. Very few of them reach the women in their courtyards. Melons are eaten raw when ripe. When green they are cooked as vegetables. The local plantains are a small, inferior variety, and are preferred

Methods of Preparing Vegetable Dishes

Preliminary process	Cooking procedure ordinarily followed	Spices	Variations in method
Potatoes: Cut up. Skins not removed. Washed after being cut up.	Fat in kettle, with fenugreek, heated. Potatoes added, and enough water to show at edges. Other spices. Cooked until potato tender. Any water left is served with it.	Fenugreek. Black and red pepper. Coriander.	Boiled, peeled, mashed. Cooked in fat in kettle with usual spices plus turmeric. Buttermilk added. Cooked fifteen minutes.
Egyptian arum: Boiled. Skins removed. Water thrown away. Chopped fine.	Fat heated in kettle with fenugreek. Arum and little water added. Spices added. Cooked until tender, and water boils away.	Fenugreek. Pepper. Coriander. Turmeric.	Same as ordinary, except that buttermilk is added in place of water.
Egg plant: Cut up. Washed.	Fat and fenugreek heated in kettle. Egg plant added and a little water. Cooked until tender. Water boils away.	Fenugreek. Dried Mango. Coriander. Pepper.	1. Like ordinary, combined with potatoes. 2. Like ordinary, with gram added.
Mustard tops: Chopped up. Washed. If dried—soaked.	Fat and asafoetida heated in kettle. Mustard and very little water added. Other spices. Water not poured off. Served with it.	Asafoetida. Pepper. Coriander.	1. Like ordinary, combined with potatoes. 2. Boiled as "greens."
Radishes: Cut up, leaves and radishes. Washed.	Fat and asafoetida heated in kettle. Radishes and tops added. Small quantity water. Spices. Cooked until radishes tender and water boiled off.	Asafoetida. Pepper. Coriander.	1. Pickled. 2. Tops cooked as "greens."
Radish seed pods, unripe. Cut up into small pieces. Washed.	Fat and fenugreek heated in kettle. Pods added. Also cut up potatoes, and water enough to show. Spices. Cooked until potatoes tender, and no water left.	Fenugreek. Pepper. Coriander. Low castes—onion.	
Water Chestnuts: Skins removed.	Fat and fenugreek heated in kettle. Nuts added with little water. Spices. Cooked until tender. Water left is poured off.	Fenugreek. Cardamom. Pepper. Turmeric. Coriander.	Roasted.

moved.	added with little water. Spices. Cooked until tender. Water left is poured off.	per. Turmeric. Coriander.	
Turayan: Skins removed. Cut up. (Kind of gourd).	Aniseed and fat heated in kettle. Gourd added. Little water. Spices. Cooked until tender. Water left is poured off.	Turmeric. Coriander. Aniseed. Pepper.	1. Same as ordinary, combined with Egyptian arum. 2. Or cooked and mashed in buttermilk.
Lauka (kind of pumpkin): skin scraped off. Cut up. Seeds removed. When green, skin and seeds remain.	Aniseed and fat heated in kettle. Pumpkin and little water added. Cooked. Spices added. Water boils away.	Aniseed. Pepper. Coriander. Turmeric.	1. May add gram. In this case, is only eaten by immediate family. 2. May be added to buttermilk.
Cluster bean: Cut up. Washed (green in pods).	Asafoetida and fat heated in kettle. Beans added and a little water. Spices. Cooked until tender. Water remaining served with beans.	Asafoetida. Pepper. Coriander.	Same as ordinary, combined with potatoes.
Cauliflower: Cut up, flowers, and stalks all together. Washed.	Fat and fenugreek in deep brass kettle—not frying kettle. Cauliflower added. A little water. Spices added. Cooked until tender. Water kept.	Fenugreek. Blackpepper. Cloves. Coriander. Turmeric. Cardamom. Cinnamon.	When cooked with potatoes, usual frying kettle is used. Red pepper and turmeric mixed with vegetables before cooking. Other spices at end.
Cabbage: Cut up. Washed.	Fat and fenugreek in kettle. Cabbage added. Little water. Spices added. Cooked until tender and water boiled away.	Fenugreek. Blackpepper. Cloves. Coriander. Turmeric. Cardamom. Cinnamon. Low caste—onions.	Same as ordinary, combined with potatoes.
Karela: (Bitter melon). Skin scraped off. Washed. Seeds remain	Melon stuffed with spices, plus dried mango, and onions (if low caste). Partially fried, then water added. Cooked until tender. Water remaining, poured off.	Coriander. Pepper. Fennel. Mustard. Asafoetida. Aniseed.	May add gram to filling.

cooked, in combination with vegetables. "Mahua" blossoms are eaten raw by the children. In case they are unusually plentiful, some are dried and cooked with vegetables later. "Bel" fruit and the wood-apple are usually roasted over a home fire until they burst. Pomegranates are rare. When they do appear, they are eaten raw. Guavas are eaten raw, usually when green. Wood-apples are also eaten raw. The sour fibre of tamarind pods is chewed by the children. Grown-ups soak the pods and make a sweet, cool drink from the liquid.

Lemons are used in "achar"—pickle. The lemons are cut up, and ground spices are rubbed into the exposed inner surfaces. The spices used are cardamom, black pepper, fenugreek, and coriander. The lemons must remain covered with the spices for four or five days before being eaten. If prepared carefully, they will keep for a year. Plums are used to make a preserve. They are cooked, dried, and put into sugarcane juice.

Mangoes are the utility fruit of the village. They are eaten raw, cooked with vegetables, and made into a variety of pickles and preserves. An oil pickle is made by cutting the mango almost in half and removing the stone. Aniseed, red pepper, and salt are ground and added to the fruit, and oil is added to coat the surface. A salty pickle is prepared by cutting the mangoes into four sections and removing the stones. They are put into a clay jar and sprinkled well with salt. Another form of mango preserve is made with sugarcane juice. Green mangoes are soaked and dried, or ripe mangoes are used, without cooking. They are dropped into a jar of strained, fermenting sugarcane juice, and left there for months or years. They are not ready for use until after remaining in the juice two months. Mangoes may be peeled, split, and dried after the stones have been removed. In this form, they may be added to almost anything which lacks flavour. A mango preserve is made by peeling the mangoes and rubbing them to a pulp with the spice-stone and roller. Salt, pepper, coriander and peppermint are added. This "chatni" (chutney) spoils quickly.

Even the kernels of the stones removed from mangoes are used. The stones are split, the kernels taken out, boiled, dried and eaten. They may be roasted, if preferred.

Animal products

Milk and milk products are the chief forms of animal food in the village. Fresh milk is seldom used, unless there is an unusually large supply. When a cow first gives milk, the fresh milk is boiled, and clabbers almost immediately. This is eaten, with or without raw sugar. It is eaten during the next four or five days, as long as the milk is drunk after boiling. After this it is made into "ghi". In most homes all of the milk is reserved for "ghi". The milk is heated slowly in a clay jar, over a nest of smouldering dung-cakes. A little buttermilk is added, and it is set aside all night. By morning it has clabbered. At this stage it is called "dahi", and may be eaten with sugar. In city homes it is often served. But in the village, it seldom stops here, but goes on to butter.

The "dahi" is put into the churn, water is added, and it is churned. When butter forms, it is taken out and put into another jar. The butter is never used, but is collected for eight days. The sour buttermilk which remains in the churn has a variety of uses. The men of the family like it with their "satua"—parched, ground cereal—in the morning. It may be used with vegetables in "reota", described among vegetable dishes. Or it may be cooked with pulses in the dishes which we treat as meat substitutes. If there is not time to use it in any of these combinations, the men drink the buttermilk. Sometimes the children have a drink. The women do not drink it.

The accumulated butter is heated in a deep kettle over the smouldering dung-cakes, or in the kettle for deep-fat frying over the fire-place. It may be heated from one-half to four hours, depending on the fire. Foreign matter which collects on the surface is skimmed off. When the heated butter is removed from the fire it is strained through a cloth. The clear fat which goes through is "ghi". It is regarded as the ideal medium in which to fry foods. Frying is an important process in village cooking, as it must be used for all foods served to guests and for food which members of the family must eat away from home, even though they eat it in their own fields. In the absence of ovens, many things are fried in "ghi" which we would bake. "Ghi" is also used in the preparation of a number of sweetmeats. In prosperous homes, it is an important ingredient in the special dishes given a woman two months before and a month after child birth.

The Brahmans of our village eat no meat. They do not take advantage of the opportunity offered them by the Sacred Law, of eating meat as sacrificial food. Manu provides that "He who eats meat, when he honours the gods and manes, commits no sin, whether he has bought it, or himself has killed (the animal) or has received it as a present from others." V. 31.

It may be that with the giving up of priestly duties, for farming, they have given up priestly privileges as well. If they were to eat meat, without sacrificial intention, they would be guilty of sin. "There is no greater sinner than that (man) who, though not worshipping the gods and manes, seeks to increase (the bulk of) his own flesh by the flesh of other (beings)." V. 52.

The attitude of our Brahmans and of the orthodox Hindus who try to follow them is expressed in the Law. "Meat can never be obtained without injury to living creatures, and injury to sentient beings is detrimental to (the attainment of) heavenly bliss; let him therefore shun (the use of) meat." V. 48. . . . "Having well considered the (disgusting) origin of flesh and the cruelty of fettering and slaying corporeal beings, let him entirely abstain from eating meat." V. 49.

It is this attitude which keeps meat out of sight in the village. The Hindus who eat it, do their buying in the Muhammadan quarters or in their own shadow stables, as quietly as the excitement of bartering allows. The goldsmiths show themselves unorthodox in many ways, one of which is meat-eating. They do not talk about it but every one knows that they eat flesh. One or two carpenter families eat meat, as well as several families below them in the caste scale. They

all limit themselves to goat meat. The cow is revered too highly to be thought of as a source of food. Muhammadans eat as much goat meat as they can afford. Living in a Hindu community they have much the same attitude as their Hindu neighbours toward beef-eating.

Hindus and Muhammadans prepare meat in the same way. They cut it up into small pieces, sear it in fat, add water and spices and cook it. They eat it with rice or bread. Meat dishes were the only ones denied me by my little Hindu cooking-teacher. She warned me that she would never touch our experimental fire-place or utensils if I were to defile them with meat. She knew that we ate meat, but that was not her responsibility, as long as it was kept out of her field of activity.

Sweepers and Dhanuks, two castes of outcastes, are the only ones who will touch pork. After watching the scavenging activities of village swine one is not surprised that their flesh is repulsive to most villagers. Only those who are brought up with the consciousness that they are themselves unclean, could eat it. The men do the butchering and divide the pig into shares. The women cut it up still further, into small pieces which can be fried and spiced, and eaten with bread or rice. The head is the most desirable share.

Fish is not classed with meat. Many eat it who abhor meat. We were surprised at the number of castes represented on the banks of drying ponds, waiting to start their "basket-fishing." On the occasional fishing days in the spring, the whole village smells of frying fish. Only Brahmans and those others who pride themselves on keeping the letter of the Law, abstain.

Eggs are prohibited almost as much as pork. The fact that eggs hold potential life makes it impossible for orthodox Hindus to eat them. In so doing they would be destroying life. A further objection to the eggs is the objection to the chickens that lay them. Chickens are kept by outcastes. No one feeds them and they wander about the lanes near the outcaste section as scavengers. They are scrawny and offensive. The outcaste families who own them eat the few eggs which they lay.

E—FESTIVAL DISHES

Special dishes are reserved for days of religious festivals, and weddings. From the passing of one festival to the coming of the next housewives and children, and often the men, recount the special dishes they have had or are going to have. A meal of toasted millet bread and stewed pulse tastes better if one thinks while eating it, of sweetmeats fried in "ghi". The pleasure of anticipation is granted to all, as those with much share with their dependents on these occasions.

"Puris"—bread of finely ground wheat flour, fried in "ghi"—appear on all feast days. The other articles vary. "Holi" is the great festival of the spring. With its coming there appear "gojha", "yasse", "chandia", "puri", "kachauri" and "halwa". For "gojha", wheat flour is ground fine, sifted through a coarse cloth, kneaded and shaped into cakes as for bread. The cakes are dried for several hours, then fried in deep fat. When fried, they are pounded into small pieces and dried

again. When well dried, they are ground in the stone flour mill, and put through the thread-strung sieve. The sifted material is combined with black pepper and crude sugar and again sifted. Raisins and "chiraunji" (small nuts) and cut up fresh cocoanut are then mixed with it. This is the filling. The crust is made of fine wheat flour, kneaded and rolled out as for small "puris". Each cake is flattened out in the hand and filled with the mixture. Then one side of the cake is folded over and the edges pressed together, very much like small turnovers. As rapidly as the turnovers are prepared they are fried in deep fat.

"Yassee" is made of rice. The rice is husked, soaked, and pounded fine. It is then beaten up with a little warm "ghi" or oil, and raw sugar is added while beating.

"Chandia" is made of split "urd." The "urd" is soaked and its husks removed. Then it is rubbed to a thick paste, together with asafoetida and salt. This paste is spread on a wet cloth in a small circle (about four inches in diameter). A hole is cut in the centre, and it is lifted from the cloth, fried in deep fat and then added to buttermilk. "Puri" and "kachauri" have been described under cereal foods.

"Halwa" is prepared by making "puris" and grinding them up as for "gojha". One pound of this is browned well in one pound of "ghi", and combined with one pound raw sugar. A little water may be added if necessary. It is like a stiff mush, patted out and cut into cubes. Raisins may be added. In town there are many variations of "halwa", such as adding grated carrot, nuts and cocoanut. But in the village, the simple form is adhered to.

In the spring, just before the last field of the winter crops is cut, the farmer's wife makes "sira". For this she browns wheat flour in "ghi". She melts raw sugar in a small quantity of water and adds hot water to it. Then she adds the browned flour and raisins and cocoanut and serves it.

The wedding season comes in May and June. Wedding parties go from our village to be entertained in other villages and wedding parties from other villages are feasted by us. There are "puris", "kachauris," "halwa", and fried vegetables and pulse dishes, all of which have been described. A special dish is called "tikian". It is made of gram flour, mixed with enough water to make a stiff dough. In a deep kettle, water is heated—about three quarts water to one pound flour. The stiff dough is made into little flat round cakes, a little larger than the palm of the hand. These cakes are dropped into the boiling water and boiled about twenty minutes, until tough. They are then lifted out and spread on a tray to cool. Each cake is cut in half, and then into cross-wise strips. The gram flour inside looks packed and uncooked. Salt, red pepper and turmeric are ground and mixed through the strips. The sticky surfaces hold the spices. Two ounces of "ghi" and a pinch of asafoetida are heated in the deep-fat frying kettle and the spiced strips are fried in it. When the strips are well browned, water is added almost to the top of the kettle. It is cooked until most of the water boils away, when salt, cloves, cardamom, and black pepper are added. It looks like noodles in thick brown gravy and tastes better than it looks.

Two festival dishes go through the same steps, but one is sweetened and one is made salty. The sweet cakes are "gul-gula" and the salty ones are "pakauri". To a pound of wheat flour a pound of melted raw sugar is added, also a small ginger root and a large cardamom. Water is added until the batter is like that for ginger bread. The frying kettle is half filled with "ghi" or oil, and heated. A handful of batter is dropped into the fat. The cakes thus dropped puff out and turn a rich brown. They are delicious, like doughnuts, with a strong molasses flavour. For the salty cakes, salt and asafoetida are added to the flour and the same procedure is followed as above. We prefer the salty cakes.

At wedding time mangoes are at their height, and appear in many forms. In addition to the preserves described, a special mango dish is prepared, called "Amiyan chinghora". Turmeric, pepper, salt and coriander are ground together. Oil is put into the frying kettle and the spices are heated in it. Gram flour and mangoes have previously been peeled and stoned. When it is ready to remove from the fire, heated asafoetida is stirred into it.

In August, during the rains, there is a festival which is a happy one for the girls. Most brides, and often women long-married, go to their father's homes for this festival, "Raksha Bandan". The dish most definitely associated with this festival is "samai". Every woman makes it. She makes a stiff dough of the finest wheat flour she can grind. She inverts a large clay jar, and on its bottom she rolls the dough into a long thin string like vermicelli. The dried branch of a tree is stood on a roped cot, and the vermicelli is draped over it. When it is dry, the whole family enjoys it, mixing it with melted raw sugar.

In the Autumn comes the Feast of Lights which is another occasion worthy of feasts. Puffed rice, plain or sweetened is the special dish for this festival. And there is "lapasi". A thin sweetened flour batter is poured into hot fat and stirred until it is a smooth thick brown sauce. This is poured out on a tray where it becomes firm almost immediately. It is patted out and cut into squares for serving. "Lapasi" may be made of wheat, maize, or barley, and may be sweetened or salted.

Another dish associated with the Feast of Lights is "pitaua". Spiked millet or great millet is ground, and combined with raw sugar and sesame seeds. It is worked into a dough, and shaped piece by piece into round flat cakes, about six inches in diameter and three-eighths inches thick. These are fried. Maize may be used in place of the millet, in which case salt is added instead of sesame. "Halwa", described under the Spring Festival, also appears on the Feast of Lights.

At any time during the year which is proclaimed auspicious, a man may give what is called "Katha". He calls in a priest to read from the sacred books, and invites all relatives within reach to come and listen, and feast. By giving a "Katha", a man gains much merit. At the feast he serves the guests mango preserve, with "Channa mirt". "Channa mirt" is a mixture of cow's milk, leaves of the holy basil tree, Ganges water, sugar, curds, and gram. It is served in little clay cups, or poured into the hands of guests. At the same time, two wheat flour dishes are served. One of these is simply wheat flour mixed with hot "ghi" and

then with raw sugar. For the other, wheat flour is made into a stiff dough with water and melted raw sugar. The dough is shaped into a long slender roll from which small slices are cut and fried in deep fat.

Among the special dishes of the village must be included those prepared for women before and after their babies are born. One such dish is "mewa kilaurna", given to a woman during the early nursing period. Cocoanut, almonds, pistachies, raisins, dried dates, are all chopped together and heated in "ghi". Gum from the gum acacia tree is added. Raw sugar and water are boiled together until it forms a thread. It is stirred into the prepared condiments and the whole is beaten and shaped into balls. It resembles Persian sweets. This is only available in the better homes.

Another special food given a woman after child-birth is "harira". Aniseed, coriander, turmeric, fennel and "ajwain" (caryota copticum) are ground together. Equal weights of these and "ghi" are combined and added to their total weight of raw sugar. A little water is added. Both of these sweets are supposed to add strength, and increase the flow of milk.

IV—FOOD PRACTICES

Certain practices in regard to food have become customary in Karimpur. They are the product of the experiences of generations. Some of them are common to all Hindu communities, others are limited to the Ganges area and still others are found only in our district. There are two sets of these practices. One set is associated with the good, and the other with the harm which may come to a person through food. Both have the support of custom, but those associated with the good which food may do, are such a simple part of daily living that one is hardly aware of them. They encourage the distribution and use of foods shown by experience to be beneficial. Those practices associated with the harm which may come through food receive much more emphasis. They take the form of food taboos, supported by religious law and ceremony.

A—FOOD TABOOS

Blunt, in his discussion of the caste system of Northern India, lists seven kinds of food taboos. (10).

> "The food taboos of Hindu life complicate it to an almost incredible degree: and as has many a time been pointed out, prevent 'the growth of the good fellowship which we are wont to cement at the dinner table.'
>
> "Hindu food taboos are of several kinds:
>
> 1. The commensal taboo—which lays down the persons in whose company a man may eat food.
> 2. The cooking taboo—which lays down the persons who may cook the food that a man eats.

(10) See References.

3. The food taboo—which lays down what kinds of food a man may eat.

4. The eating taboo—which lays down proper ritual at a meal.

5. The drinking taboo—which lays down the persons from whom a man may take water.

6. The smoking taboo—which lays down the persons whose pipe a man may smoke, and in whose company he may smoke.

7. The vessels taboo—which lays down the nature of the vessels that a man may use for eating, drinking, and cooking."

To a new-comer, these and related taboos seem an absurd waste of time. But as we observed the measures which we took to protect ourselves from disease in community with no sewers, no screens and no quarantine rules, we admired the skill with which high caste Hindus had formulated rules with all the prestige of ceremonialism, which served to protect them and their progeny from the dangers that apparently lurk in food. We tried to explain our reluctance to eat in village homes in terms of flies, and small-pox and cholera germs. But our village friends pleasantly ignored our terminology and explained our practices to each other in their own familiar terms of caste rules. They were relieved to find that although we mingled recklessly with all castes, we still maintained certain prohibitions. This discovery made us more comprehensible to them.

The Brahmans at the top of the caste scale, are meticulous in their observances of the religious law. This includes bodily cleanliness. Even our busy Brahman farmers try to bathe every day. A man stands beside a well and pours water, freshly drawn, over his body, while he repeats prayers. He wears his loin cloth while bathing and changes it for a dry one if he has it, after the ceremony is completed. After this bath he is ready to eat. No one is supposed to touch him until he has finished his food. Bose, in describing Hindu customs in Bengal, writes, "When Hindus sit together to eat, their seats are generally wooden planks or 'Kusa' grass seats placed on the floor. These seats must not touch one another and no Hindu will touch another person who is also eating by his side. Among Brahmins this rule is very strictly observed. No one except the mother and the wife can touch a Brahmin while he is eating; if he does, he will stop eating and get up and wash his hands and mouth. This is a most barbarous custom. Some Brahmins do not allow their wives to touch them while they are eating. As the mother is regarded as a goddess by all Hindus they make an exception always in her case." (11)

The Brahman wife, who serves her husband, has also bathed or at least washed her hands before preparing his food.

S. N. Jafri, Deputy Director of Public Information of the Government of India, gives an interesting picture of eating in a Hindu home of the United Provinces.

(11) See References.

"The system of taking food by the Hindu tenantry, or for the matter of that all Hindus except those who are influenced by modernism, is unique.

"They sit in a part of the floor of the kitchen which is called 'chauka' and is meant as a place for taking food. Before eating they take off all their clothes except the 'dhotees,' or the piece of cloth that goes round the waist and answers the place of trousers. In fact, other pieces are very seldom put on after bathing. The coat, the cap, and the turban, are all taken off, and a man eats with his body and head uncovered. Shoes are of course left at the door of the house. To woollen stuffs, they believe, there attaches no ceremonial uncleanliness and these they use while eating and worshipping, though they get them washed by bleachers, members of an inferior caste. In very cold weather, while eating, they generally throw a blanket over them.

"The plates containing the food are put on the 'chauka,' because placing the food anywhere else would pollute it and then it could not be eaten. All the food that is cooked is not placed in the 'chauka' at once, but only the requisite quantity. The woman of the family who is the principal cook at the time, or officiates in the kitchen, serves the food for the eater or eaters. She sits near the fireplace, where the 'chauka' is situated. The man squats, in which case he has a small smooth board under him; his knees stick up close to his chest, the joint of the left arm and hand rest upon the left knee and it is thus the hand is supported while stretched out.

"Both Hindus and Muslims eat with their fingers; knives and forks are unknown—the food is of such a kind that the fingers manage to carry it to the mouth, and thus they can eat very conveniently with one hand.

"A Hindu at the time of eating must not be touched by one of inferior caste or by a non-Hindu for, if he were, he would immediately rise and not take another mouthful, even if he had to go without food the whole day; he would also throw out that which he might have in his mouth. He would never eat food prepared by a non-Hindu or even a Hindu of an inferior caste; and to some the shadow of a low caste man falling on their victuals renders them unfit to eat. A Hindu's food is of two kinds, 'kachcha khana' and 'pakka khana.' All the above-mentioned ceremonies are required for 'kachcha khana.' No ceremonial uncleanliness attaches to dry things, such as flour and grain, and none also to fruits. Such things a man of higher caste can receive from a man of lower degree." (12)

Before one can attempt to understand the intricacies of the food "Thou shalt nots" of a Hindu community, he must know the distinction between "kachcha" and "pakka" food. Ghurye in his presentation of Caste and Race in India, gives one of the clearest statements of this distinction that I have found.

"Restrictions on feeding and social intercourse. There are minute rules as to what sort of food or drink can be accepted by a person and from what castes. But there is very great diversity in this matter. The practices in the matter of food and social intercourse divide India into two broad belts. Hindustan proper (our section of India), castes can be divided into five group; first, the twice-born castes; second, those castes at whose hands the twice-born can take 'Pakka' food; third, those castes at whose hands the twice-born cannot accept any kind of food but may take water; fourth, castes that are not untouchable yet are such that water from them cannot be used by the twice-born; last come all those castes whose touch defiles not only the twice-born, but any orthodox Hindu. All food is divided into two classes. 'Kachcha' and 'Pakka,' the former being any food in the cooking of which water has been used, and the latter all food cooked in 'ghi' without the addition of water. As a rule a man will never eat 'Kachcha' food unless it is prepared by a fellow casteman, which in actual practice means a member of his own endogamous group, whether it be caste or sub-caste, or else by his Brahmin 'Guru' or spiritual guide. But in practice most castes seem to take no objection to 'Kachcha' food from a Brahmin. A Brahmin can accept 'Kachcha' food at the hands of no other caste; nay, some of them, like the Kanaujia Brahmins, are so punctilious about these restrictions that, as a proverb has it three Kanaujias require no less than thirteen hearths. As for the 'Pakka' food, it may be taken by a Brahmin at the hands of some of the castes only. A man of higher caste cannot accept 'Kachcha' food from one of the lower, though the latter may regale himself with similar food offered by a member of one of the castes accepted to be higher than his own." (13).

(12), (13) See References.

Blunt gives the explanation of the distinction between the two kinds of food.

> "The Hindu draws a distinction between 'Kachcha' food, which is cooked in water, and 'Pakka' food, which is cooked with 'ghi' (clarified butter). This distinction depends on the principle that 'ghi' like all the products of the sacred cow, protects from impurity: and since such protection is the object of all food taboos, this convenient fiction enables the Hindu to be less particular in the case of 'pakka' than of 'kachcha' food, and to relax his restrictions accordingly." (14).

In our village "kachcha" food is an exclusive, family-only product. But on certain definitely fixed occasions a Hindu may eat "pakka" food, prepared by others than members of his own family. The persons who may cook this food are all listed in the rules of his particular caste. In this way, although he ventures to dine abroad he is still somewhat protected. The persons who may cook the feast of "pakka" food, which he shares must be his equals or superiors in the caste scale. This guarantees that they will be at least as clean as he is, if not cleaner, in the care of their bodies and their food. If he is a Brahman, he is supposed to feast only at the house of a Brahman, with the understanding that the food has been prepared by members of the Brahman household, Brahman servants, or servants of water-carrier caste. He takes for granted that any sweets too elaborate to be prepared at home, have come from a *bona fide* "halwai," maker of sweets. If doubt arises about the source of any article of food, the Brahman guest does not hesitate to make pointed inquiries of his host about it, before touching it.

The following is just a short section from pages and pages of laws stating from whom a Brahman shall not accept food:

> "The food of a king impairs his a Brahman's vigour, the food of a Sudra his excellence in sacred learning, the food of a goldsmith his longevity, that of a leather-cutter his fame. The food of an artisan destroys his offspring, that of a washerman his (bodily) strength." Code of Manu. IV. 218 and 219.

The Brahmans of Karimpur treat their goldsmith neighbours as being worthy of becoming their hosts on special occasions. At the lower end of the caste scale are the Sudras. They can eat "pakka" food or drink water from members of the long line of castes above them. But better than any other food for the Sudra is that which a Brahman has touched.

> "Sudras who live according to the law, shall each month shave (their heads); their mode of purification (shall be) the same as that of Vaisyas, and their food the fragments of an Aryan's meal." Code of Manu. V. 140.

Below the Sudras are the outcastes. They haunt the weddings and other feasts of any caste, ready to hurry in ahead of the dogs and crows, to gather up the scraps left by the guests on their leaf plates. These left-overs they carry home in baskets or ends of scarves or loin cloths. They eat what they can at the time, and dry out the rest to be eaten later. No one worries about protecting the outcastes from possible contamination.

(14) See References.

Our years in India convinced us that experience had taught the law-makers well—at least for their own benefit—in the matter of "kachcha" and "pakka" food. We found ourselves unconsciously following their practice. We learned that we could safely go to a wedding feast in a village home, where we would hesitate to eat the daily food. This was because the wedding foods were all "pakka"—fried in hot "ghi" and served at once. It was not the sacred source of the "ghi" which influenced us, but the fact that it was sizzling hot.

The weighty distinction between "kachcha" and "pakka" food complicates food preparation for the village housewife. When her husband and sons eat in the family courtyard, everything may be "kachcha." She makes the ordinary cereal cakes and toasts them, and she may cook "sag" (boiled green vegetables) or pulses. If one of the men wants his food sent to the fields where he is working, she must prepare "pakka" food for him. She cannot send boiled food to the fields, as it would be "kachcha," and "kachcha" food may not be eaten in the fields where there is a possibility that the food or the eater might be touched. So she must fry the vegetables, and she is supposed to fry the cereal cakes in deep fat. These fried cakes are made only of pure wheat flour, which she cannot afford to use often. Neither can she afford large amounts of "ghi" or oil for deep fat frying. So she toasts cakes of mixed flour in the usual way, and sprinkles a little "ghi" or oil over those which are to be carried to the worker in the fields, and pronounces them "pakka". Thus she keeps the law with a few drops of "ghi". But her problem does not end here. If she should prepare her "kachcha" food such as toasted cakes and pulse first, then any food which she prepares after it becomes "kachcha", even though it would seem to be "pakka," by being fried in "ghi". It can then be eaten only by members of the family within the courtyard. If she has "pakka" food to prepare she must finish it first, and set it aside in a prescribed place, and after that, cook the "kachcha" food. She finds it easier whenever possible, to have everything fried in "ghi"—"pakka", or everything "kachcha".

"Kachcha" food must be eaten immediately. If a woman discovers that she has prepared more of some "kachcha" food, such as boiled vegetables or pulse, than will be used at noon, she can mud plaster a corner near her fire and set some of the food there to be kept for the evening meal of the same day. But she must do this before any one has been served. If any "kachcha" food is left after a meal has been served, the women and children may eat it later on in the day or even the next morning. The men will not touch it. One appreciates this precaution after observing what might walk over food standing on the floor, even though it be in a special corner, where no human treads.

Drinking water is protected from contamination by a number of laws. Only three Brahman courtyards in Karimpur are large enough for wells. The other wells—19 in all—are along the lanes and paths. Each well may be used by certain families, and must not be touched by others. Brahman women and other women kept in seclusion cannot leave their courtyards. Women of water-carrier caste draw their water for them. Whoever uses the well lets his or her jar down into

the water. This makes it important that unclean castes and strangers be prohibited from using a high caste well. We were not allowed to get our water from any of the village wells, as the boy who carried our water was a leather-worker, and the well of the leather-workers was too far away to be used. So our water came from an irrigation well in our grove and sometimes from one in the fields. We were not as particular as our village friends about who shared our well. In place of caste prohibitions, we resorted to thorough boiling. When cholera broke out in the village one summer, the district sanitary department sent out men armed with potassium permanganate. They did not limit themselves to the wells used by contaminated households but treated all wells, for safety. Someone told our people that the permanganate was poison. As we went the rounds to re-assure them we found men laboriously trying to empty the wells of the red water, a jarful of water at a time. If the permanganate had been somehow related to ceremonial purification or if waterboiling could have been substituted and given some spirit-appeasing significance, it would have been accepted readily. But being introduced officiously, without explanation, it was upsetting.

Dishes in which food is prepared or served are carefully guarded. They are used for the immediate family only. Red clay dishes and clay cups without handles are used for guests and thrown away. They are never used a second time. This is as satisfactory as our rinsing with boiling water and it is much easier. At least so our young sons thought when we washed dishes after our own guests had departed. If clay dishes are too expensive, a host may serve his guests on plates of large leaves bound together with twigs.

At a feast, nothing is ever passed around. The host or his sons serve the men, and his womenfolk serve the women, after the men have finished. As a server moves from guest to guest he is careful not to touch anyone with his garments and he is still more careful not to touch his hands, or the big iron serving-spoon against the plate of a guest. This would render the spoon, himself, and the serving dish in his hand unclean.

Food dropped on the floor must not be eaten. The advantages of this are obvious, especially where the floors are the earth, and children and animals relieve themselves anywhere. The villager has his own explanation, expressed in an old saying, "If edibles at the time of eating drop down they are taken by the shadowy spirits and should not be picked up and eaten. If you do eat, you are sure to be possessed by the spirits who will harass you much." (15)

There are other food regulations, the burden of which rests on the women. These have to do with the ceremonies of food preparation. In the morning as soon as her grinding is finished, a woman plasters her little fireplace and the floor all around it with fresh clay. The plastered floor space extends about three feet out

(15) See References.

from the fireplace. The clay she uses is not ordinary clay. It is collected from the edge of a particular pond, by the children of the family if she is too high in caste to get it herself. She mixes the clay with a little water and a bit of cow-dung in her mixing bowl, and plasters it on the surface of the fireplace and floor with a rag kept for the purpose. When the plastering has been done, the fireplace and the plastered area around it are "purified". No one must go near them. Even the children of the family know that they must not approach it. It was not until I had my own fireplace that I appreciated the importance of this. In the absence of a kitchen table, it is necessary to have some place where one can put eatables and utensils and know that they will not be walked over. My fireplace was under a tree in our grove, with children playing all around, and farmers stopping to add their advice to that of my instructor. And only once did anyone approach this sanctum. That one was a little toddler of washerman caste. My teacher rushed at the child in a fury, and a torrent of reminders of her unworthy birth. The child fled, and we had no lesson that day. The fireplace had to go through a fresh mud-plastering before it could be used again.

While the fireplace is drying, a woman may perform any of the tasks which do not demand strict purity. She may churn or make her fuel cakes of dung or chop vegetables. When everything is collected for the meal—flour, water, pulse or vegetable, and utensils and spices—she bathes. This she does by standing in a sunny part of the courtyard and pouring water over herself and her clothes. Then she changes to a "dhoti", a scant garment made of one piece of cloth draped around the body and over the head. She never allows the village washerman to touch this garment, but rinses it out at home herself. The washerman's touch would indirectly defile her, and the food she touches. Women lower than the goldsmiths in caste, let handwashing take the place of the bathing ceremony.

When bathed, or washed, the woman enters the plastered area, by her fireplace, taking all of her materials and utensils with her. From this moment until after the men have been served, she must not leave it. The other women help with the preliminaries, but only the one who is ceremonially and physically clean, may attend to the final cooking. She alone may serve the men their food as they come and sit near her. In Karimpur the family never eats together, and even the men seldom eat together. Each one comes in when he is free, eats his meal in silence, and leaves the courtyard at once. The cook must wait until every man has been served before she is allowed to leave her post. Thus does a woman do her share in protecting the food which she gives her menfolk. For her own food, there are many less rules. She and the other women eat what the men leave. While they eat they are free to sit anywhere within the courtyard. Women are of little importance in the village interpretation of the Hindu code.

B—NUTRITION PRACTICES

The second set of food practices, mentioned at the beginning of this chapter, are much less formal and less obvious than the ones just discussed. They have risen from experience which has demonstrated the good effects which apparently result from the eating of certain foods. Most of these practices are simply an expression of physical desire for certain foods. I have called them "nutrition practices," as they express the village way of meeting body needs.

First there is the custom of sharing raw products. If there were barbed wire fences around orchards and fields our poorer families would suffer. As it is, each family of low caste with low food supply is dependant upon, and attached by custom to one or more high caste, prosperous families whom they call their patrons. When leguminous plants and mustard plants are young and their tops are tender, children of poor homes are allowed to pick them in the fields of their patrons. They gather enough so that their families have what they want to eat fresh, with some left over to dry and store for later use. The children also go into the fields of patrons and dig up certain of the green leaves which grow without tending, close to the ground. There are a number of those listed in the food table (p. 372).

With a diet based on cereals and legumes, supplemented with vegetables which are chiefly of the pumpkin and tuber varieties, villagefolk need the minerals and the vitamins which these green leaves offer. And nature and custom have combined to make the leaves available, not just to the prosperous but to all.

The same is true of sugarcane. From the time it is ripe until it is cut and pressed, one sees children and men of all castes sucking and chewing at the stalks. In so doing they are supplying their bodies with the calcium of which they get little in their low-milk diet. In the cane juice there are also the calories which they need.

At harvest time sharing reaches its high point. Every man and boy in the village has a chance to work in the harvest fields. He may be a carpenter, a potter, or a leather-worker the rest of the year, but at this time he turns farm-hand. The untouchables are the only men excluded. We asked why? One of the farmers explained, "When they work just a little while, they perspire and then they complain because they are tired." We thought at first that this was an excuse for keeping the untouchables out of the fields. One expects to have real reasons veiled. But after seeing the untouchables at lighter field work, and their quick tiring, we agreed that the farmer had expressed his actual thought. A Multan proverb says, "He that eats a 'ser' (from 2 to 3 pounds) works like a lion, but he that eats only a quarter of a 'ser' works like wood-ashes." And we wondered if this might not help explain the seeming laziness of the untouchables who have no fields of their own and who get only a meagre share from others.

The men of all castes above the untouchables, and some of the low caste women, work daily while the harvest lasts. And every night each one carries

home a headload of grain from the field just cut. This gives them varieties of grain and pulse which they would not otherwise have.

At harvest time, women who cannot work all day, follow the harvesters, gleaning. A woman may glean in any of the fields belonging to her husband's patrons. In a few hours she can gather up several pounds of heads of grain—grain which would otherwise feed the crows.

At harvest time representatives of families of craftsmen and serving castes appear at the fields of patrons at the proper time, to claim their shares. Even the outcastes have rights at this time. No questions are asked. Everyone knows whose duty it is to give, and whose right it is to receive, and the proper amount. The ethics of this system of payment may be questioned, but it assures the low caste and outcaste families of a variety of cereals and pulses which they would not otherwise get, either from their own fields or from the bazaar.

In the fruit crops, we find a high degree of sharing. As has been noted, mangoes may be gathered by any member of the village, in any grove of the village. And mangoes are apparently their chief source of Vitamin C. The tamarind pods are available to all. And long ago Sanskrit medicine found in the tamarind, a quality now recognized as anti-scorbutic.

The children are the ones who let their physical needs direct their foraging. None of the edible fruits miss them. The wild ones which they eat, we know little about. But we feel sure that they must supply some Vitamin C, and calories, and perhaps some of the iron which they need. The gum from the gum acacia tree of which they are particularly fond, must add calories, if nothing more. We tried most of the strange fruits which they brought us to sample. A few were delicious, but we would not recommend many of them for flavour. The only offering which we absolutely declined was something which they scraped from the trees of our grove. It was apparently the deposit of mud made by white ants to serve as their passageway up the side of the tree. What the children got from it which was satisfying, I cannot imagine.

When the outcastes butcher a pig they treat the head as the choicest portion. It reminds us of the boar's head, praised by our own forefathers. The outcastes have not been told why the pig's head appeals to them especially. They only know that they like it. Here, as with the children and the fruits, nature guides them.

The people of Karimpur have learned to save and eat many things which we, with our plenty, have wasted. It is comparatively recently that we have been taught that the water in which potaoes and certain other vegetables have been boiled is valuable. We try to save some of the water for soups. In Karimpur the water which is added to vegetables is so small in quantity that little or none remains when the vegetable is cooked. What does remain is eaten along with the vegetable. My village friends were horrified when they heard that in some places this water is thrown away.

They hate to throw anything away. When they cook vegetables, they never remove the skins, unless too tough for chewing. When their grain is threshed some of the finer husks remain. These come loose during the grinding of the grain into flour and are separated in the sifting. But the women are careful not to lose them. They put some back into the flour and save the rest to be mixed in with other flour which has less roughage. When I tell them that in America we separate bran, and sell it in packages apart from the flour, at a price which seems fabulous to them, they think that we must be very stupid, or at least shockingly extravagant.

When a woman prepares a batter of any of the buttermilk or pulse mixtures in her mixing basin she does the stirring with her right hand, and scrapes the basin clean with the same hand. But she is not satisfied with this. She pours water into the mixing basin, washes the basin and her hand and pours the washed product into the frying pan or jar or other container along with the original preparation. As nothing is measured exactly, this additional liquid makes little difference. And the cook prefers to have it in the soup, rather than in her open mud drain which is already messy and alive with flies.

As I walk through the village lanes on a festival day, I meet the women of serving castes, and outcaste women, going from door to door among their patrons. At each door they stand until one of the women of the patron's household tosses out several "puris" and the particular cakes or sweets associated with the occasion. If the serving woman thinks that she has not received her due, she says so, and stands talking about it until the women of the house give her something more, to get rid of her. If they think that she wants more than she should have, they shout at her until she is convinced that waiting will not profit her, and leaves. This sort of tumult alarmed me, until I learned that it was a perfectly friendly way of settling the amount of payment due. A definite payment in cash would seem more satisfactory to us. But cash, in the village is not as useful as food, especially the kind of food which is distributed on festival days. In the homes from which these low caste and outcaste women come, there is no wheat except that distributed at harvest time. They own no cows or buffaloes, and therefore have no "ghi". Meanwhile, there is plenty of wheat and "ghi" in the prosperous homes. And this method of handing them out in the form of festival cakes, assures the donors of religious merit, while giving the recipients and their children something which their bodies need.

There are sometimes other rare things used, to fill the cakes, such as cocoanut and dried dates. These help still further to meet neglected needs. It seems like an unpleasant welfare method to us. But both parties regard it as an exciting and profitable procedure. Life would be dull without the anticipation of festivals. And as yet the West has not discovered a method of caring for the unfed, successful enough to be offered as an improvement.

Among villagefolk there is a conviction that certain foods have special qualities. Some foods are "heating", while others are "cooling." We noticed that patients almost always asked what food they should eat. Knowing little about their foods, we hesitated to advise. But there was always someone around ready to speak with authority. If the patient suffered from toothache or earache, or a cold, the term "heating food" almost always occurred somewhere in the lengthy advice. If the patient had fever, "cooling food" always occurred. The reasons also seemed important. In cold weather when a person had digestive difficulties, "heating foods" were advised. In similar cases in hot weather, "cooling foods" were recommended. We collected a list of the foods which we heard mentioned in these two classes. "Cooling foods" include: buttermilk; sugarcane juice; bread of barley flour; tips of gram plants; "raskhir"; a combination of rice and sugarcane juice; radishes; carrots; Egyptian arum, or dasheen; and water-chestnuts. "Heating foods" include: bread of spiked millet; "dal" of pigeon pea; raw sugar; milk; potatoes; corn and sesamum oil. As I recall some of these foods, in the setting of an Indian hot season, I have reactions towards them, similar to those suggested by the villagers. But I have no adequate explanations of them as two distinct classes. There is no one quality running through either class which might explain its designation. Further analysis of Indian foods may disclose a reason. At present, I simply offer the lists as demonstrating the effort of village folk to express the possible effects of food.

Another class of foods accepted in the village is that of "strengthening" foods. These are supposed to give superior strength to the already strong, or to restore strength to the weak. The goldsmith brothers who act as village wrestlers, and are the acknowledged "strong men", eat almonds and pistachies, both of which are luxuries from the Mainpuri bazaar. While in training, they give up meat, and add milk to their usual diet.

Strength-giving foods are considered important for expectant and nursing mothers. Two dishes reserved for them, "mewa kilaurna" and "Harira", are described in the section on festival dishes. These are too expensive for most homes, where simpler festival dishes of wheat or gram flour, rich in "ghi" and raw sugar, are substituted. Cocoanut and "phaphola" (nymphaea lotus) are included if possible, even though they must be begged.

For anyone who has become very weak, without particular reason, mixtures like the two following are recommended by the local practitioners. Three drams of roots of the okra, and twelve black pepper corns, ground together. This is one dose. Or, one green seed pod of the gum acacia tree and ten black pepper corns. Grind and make into sherbet, with one cup of water. Sweeten to taste. Drink this every morning until strength returns.

Sunshine is an acknowledged blessing in the village. Every morning good Brahman farmers chant hymns in its praise. We agreed with them, that but for the sunshine we would all have died. On several occasions, we found boys with smallpox scabs still peeling, riding with others on our boy's wagon or tricycle. We

washed the playthings with disinfectant immediately. But we had to trust to the sun to save us from the germs which had had time to attach themselves before the discovery was made.

In the rainy season one appreciates the sun, by its absence. After a few days of heavy clouds and rain, the village lanes are like pools, fed by the streams which trickle from open house-drains and privies. The smells which rise up to greet one are nauseating. A few days of bright sunshine clear the pathway and atmosphere. The streams still trickle but they dry up before they become objectionable.

In this discussion, however, we are more interested in the sun's light as a source, or producer of, Vitamin D. As far as we know, it is the villager's sole source of Vitamin D, except for a small amount which he may get from green leaves. I have heard Westerners inquire, "If sunshine is beneficial, then why aren't Indian children large and stronger than they are?" This is demanding too much of sunshine. It cannot be expected to correct all diet defects. I have heard American doctors reply, that in rural India sunlight does well the work which they look to it to do. If our village children depended upon diet alone for adequate supplies of calcium and phosphorus, and for proper mobilization of the supplies, cases of rickets would be much more general and extreme than they are. I have found no definite records, beyond that of the work of Dr. Hutchinson and Dr. Shah. "A recent study of rickets in India by Hutchinson and Shah is clearly illustrative of the preventive role of sunlight. Surely there should be no rickets in India. Yet the infants of the top caste Hindus almost always develop extremely severe rickets. Owing to the religious custom of 'purdah,' which compels their mothers to live beyond the public gaze, these infants are practically never taken out of dusky rooms. In contrast the infants of Hindu laborers who cannot afford too expensive a religious detail practically never develop rickets. The women work with the men in the fields and leave their infants along-side in the sunlight. The rickets preventive action of sunlight is here particularly clear cut, since in both instances the dietaries of the mothers almost entirely lack the food-stuffs which contain the substance D." (16).

In Karimpur, custom co-operates with nature, in supplying sunshine to all castes. The women live and work in roofless courts. A few of these courtyard admit little sun in the winter months, but even they are better than stuffy rooms. Babies of all castes creep around naked during nine months of the year, and during the remaining three months they wear abbreviated cotton skirts. The children work in the fields or play in the lanes in scanty clothes which grow scantier with increasing heat. No one wears stockings, and few wear shoes. Craftsmen, instead of working in shops or work-rooms, carry on their crafts in village lanes or in open courtyards. The washerman, assisted by his whole family works beside a pond near our grove, not in a dark basement. Every one lives in the sunlight. And the sunshine blesses them. We have no cases of severe rickets in the village.

(16) See References.

Some of the attitudes of our people toward food are expressed graphically in sayings and proverbs. These are an expression of their experience with food. Some of them are revealing enough to be included in this study of their practices. The rhythm of the lines is lost in translation.

"Juar (great millet) is my mother and makes my cheeks swell like raised sweet-cakes. Bajra (spiked millet) is my brother and restores my wasted form."

"Whoever eats 'mung' pulse daily, becomes flatulent and drowsy."

"Don't call me 'arhar' (pigeon pea). My name is dear maiden. When all other grains are gone you come fumbling after me. Don't call me 'arhar'! My name is dear maiden. Two cakes of me are as filling as sixteen of other grains."

"Arhar with dried mango and an ounce of 'ghi' makes a dish for the king."

"Rice is good, but split peas are my life."

"Everything is false in the world, save pulse and bread."

"Eat bitter melons in September, radishes in August, and raw sugar in April—this is the way to spend your money and buy illness."

"Two things agree with a man—his own wife, and plain toasted cakes and pulse."

"Two things bring pain—'puris' (cakes fried in deep fat) and strange women."

V—VALUE OF FOODS NOW IN USE

The scientific study of food in India seems to have originated in the planning of diets for prisoners. In 1880, Surgeon-Major T. R. Lewis in his annual report points out a phase of the vegetarian diet of our people, which more recent students of nutrition have emphasized:

> "That chemical analysis, however exhaustive, can only afford such information as will enable a proximate estimation to be formed of the nutritive value of any food seeing that it is not only what nutriment a particular food-stuff contains that is of moment, but also what portion of it can readily be digested and assimilated by the body. In a diet composed entirely of vegetable substances, the quality of the cooking is of much more importance than it is in animal food dietaries, seeing that a large proportion of nutriment contained in cereals and pulses is enclosed in extremely resistant, indigestible envelopes, which if not effectually disposed of by proper cooking defeat all attempts on the part of the digestive organs to profit by the food . . . . . In some cases, however, the excess of nitrogenous elements is given in the form of parched, or otherwise imperfectly cooked grain, so that it is probable that a large proportion of the contained nutriment will not be assimilated. On several grounds, therefore the addition of undue proportion of pulses—and especially ill-cooked pulses—is a doubtful advantage, and may be even injurious." (17).

The most outstanding contributions in the study of jail dietaries were those made by Major D. McCay, of the Medical College, Calcutta. His first investigations were in Bengal, but it is his investigations into the jail dietaries of the United Provinces in which we are particularly interested. His statement of the jail dietaries in use in 1910 is useful in a consideration of diets of North India.

> "The diet scales for adult native prisoners on hard labour consist of 1 lb. 12 oz. of a cereal pulse combination, 2 oz. of 'dal', 6 oz. of vegetables with salt, a little oil and chilli. The cereal pulse combination is invariably made up according to the subjoined table:

Combination diet	Principal		Adjuvant		
	Grain	Quantity	Grain	Quantity	Total
A	Wheat	1 lb. 6 oz.	Barley	6 oz.	28 oz.
B	Spiked millet	1 lb. 8 oz.	Pulse	4 oz.	28 oz.
C	Maize	1 lb. 8 oz.	Pulse	4 oz.	28 oz.
D	Millet	1 lb. 7 oz.	Pulse	5 oz.	28 oz.
E	Wheat	1 lb. 7 oz.	Gram	5 oz.	28 oz.
F	Great millet	1 lb. 6 oz.	Pulse	6 oz.	28 oz.
G	Barley	1 lb. 6 oz.	Wheat	6 oz.	28 oz.
H	Rice	1 lb. 4½ oz.	Wheat	7½ oz.	28 oz.

> "Any two of the above may be combined by taking half of each principal and half of each adjuvant; thus $\frac{B+C}{2}$ will give spiked millet 12 oz. + maize 12 oz. + pulse 4 oz. = 28, or $\frac{A+C}{2}$ will give wheat 11 oz. + barley 14 oz. + pulse 3 oz. = 28.
>
> "These are the official diet scales as sanctioned in the Jail Code, but in practice they are to a large extent ignored. The only diet commonly in use is Diet E of the above table; in fact it is the only one given in the majority of the jails all over the Province. During the cold weather months great millet, spiked millet, and barley are sometimes made use of, but hardly ever in the quantities laid down. The different superintendents give their own combinations of these food-stuffs with wheat and pulse, which are usually very different from the diets officially sanctioned.

(17) See References.

"Rice has been very rarely used in the United Provinces. As it is only grown to a limited extent, the price is prohibitive. It was, however some years ago used in two district jails, close to the borders of Bengal, but an outbreak of Beri-Beri in both of these caused it to be discontinued and its use has never been revived.

" 'Marua' (millet) is never given at all; in fact, we failed to obtain samples even for analysis from the different jails, where investigations were carried out.

"Maize is seldom, if ever used: why this is so we do not understand as it is a very nutritious food-material and certainly superior to some of those in use.

"The pulses made use of in the United Provinces are principally 'arhar dal' (pigeon pea) and 'urd dal.' It would appear from the above table gram 'dal' is not classed as a pulse, but this is mistake as gram 'dal' belongs to the pulses.

"For at least nine months in the year Diet E, i.e.—

Wheat	1 lb. 7 oz.
Gram	5 oz.
Arhar dal (pigeon pea)	2 oz.
Vegetables	3 oz.
Salt	150 grains.
Oil	9.08 grams.
Condiments	2 oz.

is given to the exclusion of all others." (18)

The diet now in use in our Mainpuri District Jail is practically what McCay recommended as a result of his investigatons.

In jail, the prisoners have a cereal, a pulse, and a vegetable daily. Our village people are glad if they can have a pulse or a vegetable with their cereal bread. They rarely have both on the same day. And sometimes they have neither, and eat salt with their bread. But the villager spends his time in the fields where he may snip off the green tips of plants or roast a handful of grain. The prisoner's fare is exactly that which is recorded. The farmer's is very likely not exactly what we have recorded.

McCay has some interesting comments on the contents of jail diets as compared with diets of the province outside the jail.

"We may, therefore, conclude this consideration of the pulses of these diet scales, by stating that they are present in quantities much in excess of what is required, and in far greater abundance than the people of the Province can afford, or wish to have. Two and a half chittacks or five ounces is the maximum amount of pulse that should enter into any diet, and, if gram is to be given it should be properly cooked, not made use of as parched gram, and it should never be the only pulse in the composition of the diet. The superiority of 'arhar dal' (pigeon pea) and the fact that it is the favourite form of pulse with natives of the United Provinces should ensure that this pulse will be used in all diets to as great an extent as possible. 'Urd dal' being more suitable than other forms in the preparation of 'bajra' (spiked millet) and 'juar' (great millet) for consumption, this 'dal' should be used in diets into the composition of which those cereals enter. One chittack (2 ounces) of 'urd dal' will be found amply sufficient in the cooking of the quantities of 'juar' or 'bajra' recommended in new dietaries." (19).

"Diet C in which the principal is 'makka' or maize, we have not investigated. It is never used, so far as we could gather, in the dietaries of the prisoners. Maize we found in Bengal was a very good food-material although not very palatable as prepared in Bengal Jails. It is not suitable alone for baking into bread or 'chapatti,' but is very good when mixed with wheat or prepared as porridge. We do not think it suitable as a principal, as in Diet C, but see no reason why maize should

(18), (19) See References.

Diet used in the Mainpuri Jail, 1928

——	Bread	Dal (split pulse)		Parched gram	Rice instead of ata	Vegetables	Mustard oil	Salt	Chilies	Turmeric	Dried mango
		With bread	With rice								
Labouring	24 oz.*	2 oz.‡	4 oz.	4 oz.	16 oz. (48 oz. if cooked).	8 oz.	8 gr.	9 gr.	1 gr.	1 gr.	70 gr.
Non-labouring ..	20 oz.†	2 oz.‡	4 oz.	None	12 oz. (36 oz. cooked.)	8 oz.	8 gr.	9 gr.	1 gr.	1 gr.	70 gr.

*November to March, 16 oz. spiked millet, 8 oz. wheat—daily.
April to November, 16 oz. wheat, 8 oz. gram—daily.
†November to March, 13½ oz. millet 6½ oz. wheat—daily.
April to November, 13½ oz. wheat, 6½ oz. gram—daily.
‡November to March—5 days: 2 oz. arhar (pigeon pea).
2 days : 2 oz. mung or urd.
April to November—7 days : 2 oz. arhar (pigeon pea).

not be given as a substitute for part of the wheat in dietaries. Why it should never be given in the jails of the United Provinces is difficult to understand, as, next to wheat, maize is the best cereal on the list. It is used during its season fairly largely by the inhabitants of the province, and the average crop being up to one million tons, there cannot be any great scarcity of this food to enhance its price. We are strongly of the opinion that maize has been neglected unjustly, and that, if given as we suggest, mixed with wheat, it would be found quite satisfactory." (20)

"Judging from inquiries we have made, wheat is the food of the higher and middle classes and a luxury to the poorer. In times of scarcity or famine, when wheat, gram and 'juar' are practically the same price, wheat is eaten largely by the people, but in ordinary times 'bajra' and 'juar' are the principal food-materials of the poorer classes and small cultivator.

"Makka or maize is also largely used as a food-material, barley and 'marua' not to so great an extent as the other cereals. 'Arhar dal' is the favourite form of pulse, and a small amount is partaken of daily.

"It is, therefore, only right and fair to the prisoners that these secondary food-materials, 'bajra,' 'juar,' 'makka,' barley and 'marua,' should not be denied them. While they are not suitable to be used alone, when given along with wheat, in the manner we have indicated in the diets suggested, they are exceedingly useful in varying the monotony of the wheat diet, and in providing food-materials to which the great mass of the prisoners are accustomed. (21).

". . . . from a physiological point of view it must be admitted that the dietaries at present in force, or any framed in future to maintain the same level are distinctly superior to those available for the great mass of the population, and that this will tend to place a premium on crime in periods of scarcity. This, however, is a problem with which we have no concern; we simply point out its bearing in passing and leave the present policy of the maintenance of the superiority of jail dietaries, over those possible to the same classes outside the walls of the jails, to be determined by the government of the country." (22)

We hope that our people will find an adequate diet without being obliged to go to jail to find it.

McCay's investigations led him to the conclusion that the protein factor determines the place of Indian races in the scale of physical efficiency. He traced all differences in physique to the different levels of nitrogenous interchange possible in the diet of wheat-eaters and the diet of rice-eaters. If he had made his investigations a few years later he would have modified his conclusions to include minerals and vitamins.

Since the studies of McCay there has been an increasing interest in the study of foods in India as elsewhere. But very little scientific work has been done. Colonel R. McCarrison has contributed more than anyone else through his experiments and through his efforts to use the results of his experiments in educating Indians in the possibilities of indigenous foods. He was a member of the Indian Medical Service until 1919 when he became Director of the Deficiency Diseases Inquiry, in the Pasteur Institute, Coonoor.

(20), (21), (22) See References.

One experiment which he carried on with two colonies of rats (20 in each colony) contrasted what he calls a "good diet" with a "bad diet." "One colony received a 'good diet,' designed to resemble that eaten by the Sikhs. It consisted of 'chapatties' made of whole wheat flour; uncooked, green vegetables, fresh fruits (tomatoes, etc.); sprouted gram (legumes); butter; fresh whole milk; and fresh meat occasionally." (23) Liberal quantities of each article were supplied so that the animals could select for themselves the amounts of each they cared to eat.

This diet is of interest to us, because all of the foods in it are available in our part of the country. Our village folk grow wheat, but they sell much of it. They do not grow as many green vegetables as they might, but at the same time they make use of every edible leaf within reach. They have plenty of gram, but they are accustomed to parching or cooking it. It would be easy for them to sprout it. They could grow tomatoes and oranges and lemons. Prejudice keeps them from growing tomatoes, and they have not tried growing citrus fruits, other than a few lime trees. Oranges are now grown in our area of the Province, and can be grown in Karimpur. They would be in season during the months when there are no mangoes. The village folk might have butter, but they clarify it all to make "ghi." The same is true of milk. There is milk in almost every home and some families drink it. But in most households the milk is heated and churned to be made into "ghi." As for meat, a few eat it now. The meat at present sold is very inferior, coming from old, decrepit or diseased animals. It is a poor recommendation for meat-eating.

Colonel McCarrison's "poor diet" consisted of foods eaten by any Western people of the poorer classes—white bread, cooked vegetables, a cocoanut oil margarine, canned meat and jam, with preservatives, and tea, with milk and sugar.

The experiment lasted six months, during which time all of the rats were given equally good care. They all had a two-hour sun bath daily. During the six months, three rats out of the 20 on the "good diet" died, one of them from injury. Nine of the 20 rats on the "poor diet" died. Three of these were killed and eaten by their fellows. After this, the rats of the ill-fed colony were separated every night and a small quantity of fresh vegetables was given three times a week. The other six died from broncho-pneumonia. There were 20 litters of rats born in the well-fed colony, and all of the 134 born were reared to maturity. In the ill-fed colony, two litters were born, one of seven and one of four rats. Two of these eleven died and the others were eaten before they could be removed.

The aggregate body weight in each colony was 2,540 grams at the start. At the end of the experiment, the aggregate weight of the "well-fed" colony (17 rats) was 3,170 grams, whereas that of the eleven survivors of the ill-fed colony was 1,300 grams.

Colonel McCarrison's conclusions are:

> "Not only does the former (good diet) promote physical efficiency and health but the latter (poor diet) gives rise to stunting of growth, to physical inefficiency, and often-times to disease. The maladies of which the bad diet is so apt to lay the foundation are lung-diseases and gastro-intestinal disease." (24)

(23), (24) See References.

This last statement is based on his post mortem examinations.

Our people have the symptoms of the bad diet, while the good diet is within their reach. Experience has taught them much. But Science can add what experience has evidently missed. Few of them can read and those few see no newspapers or journals. The contributions of Science have no way of reaching them as yet. With its help they will be enabled to build up stronger bodies, without the need of importing new foods. With the raw materials already available, they have a better selection of foods than people in the West who are not as poor as they.

An article by Colonel McCarrison which appeared in "The Practitioner" on "The Relation of Diet to the Physical Efficiency of Indian Races" (25) is of value in our study. It is worth quoting at length.

"Few who have travelled far in India can have failed to notice the remarkable differences in physical efficiency of different Indian races. So great is the contrast between certain stalwart, vigorous, and resolute people of the North and certain poorly developed and toneless inhabitants of the South and East, that the question arises: Why should there be these great differences between one race and another? In attempting to answer it, I shall put aside such factors as climate, prolonged exposure to the actinic rays of the sun, peculiar religious customs and endemic diseases. For while it cannot be doubted that these play their part in determining the position of different Indian races in the scale of physical efficiency diet is the most important of the factors concerned. . . . .

"The food materials available to the people of India . . . are mostly derived fom the vegetable kingdom. They include rice, wheat, barley, maize, millet, legumes, vegetables and fruit. For various reasons—of which locality, poverty, religious scruples and habits are the chief—milk and milk products, eggs, and flesh meat enter little, if at all, into the diet of great masses of the people. The use of these commodities is confined, as a general rule, to the better classes and to certain races in Rajputana, the Punjab, Northern India, and the West Coast. The staple food of the masses thus consists of 'those parts of plants which have the function of storage tissues' (McCollum), viz., cereals and legumes. 'These are deficient in at least three dietary factors. All contain protein of relatively poor quality; all contain too little of certain mineral elements, especially calcium, sodium, and chlorine and all are deficient in fat-soluable vitamin A. It is true that the diet is supplemented with vegetables and fruits, but these are not eaten in sufficient quantity to compensate for the defects of the cereals and legumes. For these reasons the diet of many millions of people in India is an incomplete one which 'does not contain all the complexes necessary for the construction of living protoplasm' (McCollum). Now it is, to a large extent, in proportion to the way in which the defects of what may be called 'the basal diet' of the people of India are made good by the use of other foods containing more suitable protein, more of the essential mineral elements, and more vitamins, that the physical development and well-being of the different races of India depend.

"The least satisfactory of all the diets in common use in India is that consisting of rice, 'dal' (legumes), vegetables and condiments. This diet is used by millions of people in Bengal, Madras, and elsewhere; and it is these who exhibit the lowest grade of physical efficiency and health."

We need not follow in detail, as it does not apply to our section of the country.

"If now it be found that the diet of other races is such as corrects some or all of the five faults pertaining to the diet of rice and legumes, then, other things being equal, the better diet ought to be associated with a higher grade of physical efficiency in the races using it; this is precisely what we find. For when we pass from the rice and legume eaters of Lower Bengal to the wheat and legume eaters of the United Provinces—climate and other factors being practically the same in both localities—we see that the latter are 'better developed physically, more capable of hard work, hardier and more alive than the average resident of Bengal of the same class" (McCay). The reasons for this are that wheat provides a protein of better quality than rice; the composition of the diet admits of the absorption of a larger amount of protein, of the attainment in short of a higher level of nitrogenous interchange (McCay); there is not the same ingestion of carbohydrates nor the same tendency to gastro-intestinal disturbance; the deficiency

(25) See References.

of mineral elements is not so great, and the diet is, in general, richer in vitamin B. It is, however, faulty in regard to the quality of its protein and to its content of mineral essentials and of vitamin A; and since its users do not, as a general rule, supplement it with a sufficiency of other foods, rich in those elements and complexes in which it is poor, they lag behind, in physical development and well-being those races that do."

This describes the people of Karimpur. They are better developed than those of the south, but they have not reached the degree of physical efficiency attained by the races further north, whom McCarrison proceeds to describe.

"The high degree of physical efficiency of the Sikhs is attained on a diet of wholemeal bread, legume seeds, tubers and roots, vegetables and clarified butter, supplemented with liberal amounts of cow's, buffalo's or goat's milk (whole milk, buttermilk and curds). Beef is never eaten by them, but goat's flesh, mutton and game are eaten occasionally, although not in large quantities. In Sikh regiments, for instance, a pound of meat is eaten by each man two or three times a month, while 16 ounces of milk are taken daily. In their own homes much larger quantities of milk are used than is possible in regimental life. It is to be noted that milk and milk products are constant constituents of their food, other animal foods being regarded more as a luxury than as a necessity. Their children are breast-fed for two and a half years, the mother's milk being supplemented with diluted cow's or buffalo's or goat's milk during the later months of lactation; thereafter they are given liberal amounts of milk and are gradually brought on to the diet in use by their elders. The Sikhs use vegetables freely, but they do not eat fruit to the same extent as certain hill people whose climate is more suited to its cultivation.

"The food of the Pathans is much the same as the Sikhs, but they eat more meat and less legumes. They have the advantage of a better climate and more fruit and nuts are available for their use—mulberries, walnuts, etc.

"The people of Hunza make less use of meat than either the Sikhs or the Pathans. Their food is much the same as that of the Sikhs but less rich in milk, their stock being confined to goats. They are, however, great fruit-eaters, especially of apricots and mulberries. They use apricots and mulberries in both the fresh and dry state, drying sufficient of their rich harvest of them for use throughout the autumn and winter months. Dried mulberries are mixed with their wholemeal flour and made into cakes which form their staple article of diet. Meat is a luxury used only on special occasions. These people are unsurpassed by any Indian race in perfection of physique: they are long lived, vigorous in youth and age, capable of great endurance and enjoy a remarkable freedom from disease in general. To see a man of this race throw off his scanty garments and plunge into a glacier-fed river in the middle of winter is to realize that enforced restriction to the unsophisticated foods of nature—provided these be of the right kind—is no bar to the attainment of perfecion of physique.

"The diet of these three races—the Sikhs, the Pathans and the people of Hunza—provides an interesting example in man of the accuracy of the conclusions drawn by McCollum as a result of his extensive inquiry into the kinds of diets which succeed best in nutrition of animals. Putting aside the carnivorous type of diet on which satisfactory nutrition can be maintained there are two other types which he has found to be successful; (1) the seed, tuber, root and muscle type of diet which is supplemented with liberal amounts of leafy vegetables and or fruit; and (2) the type of diet derived from cereals, legume seeds, tubers, fleshy roots, with or without meat, supplemented with liberal amounts of milk—'milk being so constituted as to make good all the deficiencies of these classes of foods.' The diet of the Sikhs is practically identical with the latter type; that of the Pathans with the former; while that of the people of Hunza is a happy combination of 'the storage parts of plants,' leafy vegetables, fruit and milk, which gives, perhaps, the best result of all.

"So much then, for the relationship of diet to the physical development of the Indian races. There remains now to consider, very briefly, the extent to which their diets predispose them to disease or secure their freedom from it. We have seen that the great mass of the people of Bengal and Madras live on a rice-and-legume diet having at least five faults. Associated with these faults we find in Bengalis and Madrasis an unusual susceptibility to infection, a proneness to gastro-intestinal diseases—notably diarrhoea and dysentry—and a marked tendency to certain deficiency diseases—beri-beri, malnutritional oedemas, epidemic dropsy, and xerophalmia, which are not exhibited by races whose diet has not these faults. In regard to the proven effect of such food in lowering the natural resistance to infection, it is to be regretted that in India, as elsewhere, epidemiological inquiries have not kept pace with those in the laboratory. But in this connexion it may be remarked that the much higher incidence of leprosy in the South West, and

East of India than in the North has probably a nutritional basis. The high incidence of dysentery in the jails of Bengal as compared with its low incidence in those of the Punjab is another example of the same kind.

"Contrast now with these morbid effects of food having the faults above referred to—faults present in some degree in many dietaries at Home as well as in India—the state of health of the people of Munza who combine their foodstuffs so happily. With them resistance to infection is remarkable: anthrax, for example, does no more than produce a malignant pustule, while septicaemia is its common consequences in those less resistant to infection. Gastro-intestinal complaints—dyspepsia, gastric and duodenal ulcers, colitis and appendicitis—are as uncommon amongst them as they are common elsewhere. Even cancer is so rare that in nine years' practice I never came across a case of it. It may be that their seclusion or the mountain barriers which separate them from the rest of Asia has kept them free of many diseases carried by infected persons, but there can be no doubt that their freedom from disease is largely due to the food they eat and the health-giving life they lead in a bracing climate."

After this clear picture of MacCarrison's of the possible range of diets from foods grown in India, it will be of interest to observe the foods available in our particular area. The following table is a summary of the Food Sources discussed in Chapter I.

References used in identifying the products were:

(*a*) "The Commercial Products of India" by Sir George Watt (Published under the authority of His Majesty's Secretary of State for India in Council). John Murray, London.

(*b*) "Food Grains of India", by A. H. Church. Chapman and Hall, London.

(*c*) "Flora of the Upper Gangetic Plain", by J. F. Duthie.

When names were too local to be found in any of these, specimens were sent to Winfield Dudgeon, PH.D., Botany, of Ewing Christian College, Allahabad, who identified them for us.

Foods available in Karimpur by months

Names			Sources	When available											
English	Local	Botanical		Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	Mar.
Cereals															
Wheat ..	Gehun ..	Triticum vulgare ..	Own fields or other fields of village.	×	×	×	×	×	×	×	×	×	×	×	×
Maize	Makka ..	Zea mays ..	Fields of village	..	..	..	..	..	×	×	×	×	×	×	×
Rice	Dhan ..	Oryza sativa ..	Ditto	×	×	×	×	×	×	×	×	×	×	×	×
Millet	Marua ..	Eleusine coracana ..	Ditto	..	..	..	..	..	×	×	..	..	..	..	..
Italian millet ..	Kakun ..	Setaria italica ..	Ditto	..	..	..	..	..	×	×	×	×	..	..	..
Wild millet ..	Dhuniya ..	Like marua ..	Grows wild	..	..	..	..	..	×	×	..	..	..	..	..
Little millet ..	Kutki ..	Panicum miliare ..	Fields of village	..	..	..	..	..	..	..	×	×	×	..	..
Spiked millet ..	Bajra ..	Pennisetum typhoideum	Ditto	..	..	..	..	..	..	..	×	×	×	×	×
Poor man's millet	Sama ..	Panicum colonum ..	Ditto	..	..	..	..	..	..	×	×	..	..	..	..
Great millet ..	Juar ..	Sorghum vulgare ..	Ditto	..	..	..	..	..	..	..	×	×	×	×	×
Barley ..	Jao ..	Hordeum vulgare ..	Ditto	×	×	×	×	×	×	×	×	×	×	..	×
Wild rice ..	Pasai ..	May be variety of oryza coarctata.	Edges of tanks near village ..	..	..	..	..	..	..	..	×	×	..	..	..
Pulses															
Thick pea (gram) ..	Channa ..	Cicer arietinum ..	Fields of village	×	×	×	×	×	×	×	×	×	×	..	×
Cluster bean ..	Dararhi ..	Cyamopsis Psoralioides	Ditto	..	..	..	..	..	..	×	×	..	..	..	..
Cow pea ..	Ronsa ..	Vigna catjang ..	Ditto	..	..	..	..	..	..	×	×	..	..	..	..
	Urd ..	Phaseolus mungo* ..	Ditto	×	×	×	×	×	..	..	×	×	×	×	×

As in the rest of the paper the spelling is reproduced exactly as in the original.

	Urd ..	Phaseolus mungo* ..	Ditto	×	×	×	×	×	..	..	×̲	×̲	×̲	×̲	×̲
	Mung ..	Phaseolus radiutus* ..	Ditto	×	×	×	×	×	..	..	×̲	×̲	×̲	×̲	×̲
Aconite Bean ..	Moth ..	Phaseolus aconitifolius	Ditto	..	×	×	×	×	..	..	×̲	×̲	×̲	×̲	×̲
Field pea ..	Mattar ..	Pisum arvense ..	Ditto	×̲	×	×	×	..	..	..	..	..	..	..	×̲
Pigeon pea ..	Arhar ..	Cajanus indicus ..	Ditto	×	×	×	×	×	×	×	×̲	×̲	×̲	×̲	×̲
Variety of pea ..	Tipakua mattar.	..	Ditto	×	..	..	..	..	..	..	..	..	..	..	×
String bean ..	Sem ..	Canavalia ensiformis ..	Local vegetable growers and those of other villages.	×̲	..	..	..	..	..	×	×	×	×̲	×̲	×̲
Vegetables															
Egg plant ..	Bangan ..	Solanum melongena ..	Local vegetable growers, near by villages Mainpuri bazar.	×̲	×	×	×̲	..	..	×	×	×̲	×̲	×̲	..
Variety of pumpkin	Lauka ..	Cucurbita pepo ..	Local vegetable growers, near by villages, Mainpuri.	×	×	×	×	×	..	..	..	..	..	..	×
Form of watermelon	Kalinda ..	Citrullus vulgaris ..	Near by villages	×	..	..	..	..	..	..	..	..	..	..	..
Melon like cucumber	Kakari ..	Cucumis utilissimus ..	Local vegetable growers and near by villages.	..	×	×	×	..	..	..	..	..	..	..	..
Onions	Piaz ..	Allium cepa ..	Other villages	×	×	×	×	..	..	..	..	..	..	..	..
Egypt. arum dasheen	Ghuian ..	Colocasia antiquorum ..	Own fields or Mainpuri ..	×	×	×	×	×	..	..	..	..	..	..	×
Leaves of arum ..	Ghuian ..	Colocasia antiquorum ..	Own fields or Mainpuri ..	..	..	..	..	..	×	×	×	..	..	..	..
Gourd	Lauki ..	Lagenaria vulgaris ..	Local vegetable growers or Mainpuri.	×̲	×̲	×	×	×	..	..	..	..	..	..	×̲

*These two reversed by Roxburgh.
×̲ Available in large amounts.
× Available in lesser amounts.

Foods available in Karimpur by months—(continued)

English	Names		Sources	When available											
	Local	Botanical		Apl.	May	June	July	Aug.	S p.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Vegetables—(concld.)															
Bitter melon ..	Karela ..	Momordica charantia ..	Local fields, little from Mainpuri.	..	..	×	×	×	×	..	..	..	..	..	..
Okra	Bhindi ..	Hibiscus esculentus ..	Own fields. Grown with cotton.	..	..	..	×	×	×	×	..	..	..	..	..
Cucumber ..	Khira ..	Cucumis sativus ..	Own fields	..	..	..	..	×	×	×	..	..	..	..	..
Kind of gourd ..	Turayan ..	Luffa acutangula	Own fields with maize. Local vegetable growers.	..	..	..	..	×	×	×	×	..	..	..	..
Mushrooms ..	Kathpal ..	Agaricus campestris(?) ..	In fields	..	..	..	..	×	..	..	..	..	..	..	..
Melon like cucumber	Kacheria ..	Cucumis melo var. mamordica.	In cotton or maize fields ..	..	..	..	..	×	×	×	..	..	..	..	..
Related to cucumber	Sendha ..	Cucumis trigonis(?) ..	Local vegetable growers ..	..	..	..	..	..	×	×	..	..	..	..	..
Like cucumber ..	Arui Kacheria	Like Kacheria. Seeds not bitter.	Ditto ..	..	..	..	..	..	×	×	..	..	..	..	..
Variety of yam ..	Ratalu ..	Dioscorea bulbifera, var. pulchella.	Fields of village, little from Mainpuri.	..	..	..	..	..	..	×	×	..	..	..	..
Cauliflower ..	Phulgobi ..	Brassica cleracea var. Botrytis.	Vegetable growers of other villages.	..	..	..	..	..	..	×	×	×	×	..	
Radishes ..	Muli ..	Raphanus sativus ..	Local vegetable growers (pickled after December).	..	..	..	..	..	..	×	×	×	×	..	
Potatoes ..	Aiu ..	Solanum tuberosum ..	Own fields and vegetable	×	×	..	..	..	..	..	×	×	×	×	

Potatoes ..	Aiu ..	Solanum tuberosum ..	Own fields and vegetable growers.	×	×	..	..	..	..	..	..	×	×	×	×
Horse radish ..	Senjna ..	Moringa pterygosperma ..	Own fields (pickled) ..	×	×	..	..	..	..	..	..	×	×	×	×
Carrots	Gajar ..	Daucus carota ..	Local vegetable growers (pickled March-April).	×	..	..	..	..	..	..	..	×	×	×	×
Radish seed pods ..	Muli ki phali	(*See* radish)	Local vegetable growers ..	..	..	..	..	..	..	..	..	×	..	..	..
Sweet potatoes ..	Shakkarqand	Ipomoea batatas ..	Vegetable growers and own fields.	..	..	..	..	..	..	..	..	×	×	×	×
Cabbage	Gantor Band Gobi.	Brassica cleracea, variety capitata.	Mainpuri	×	..	..	..	..	..	..	..	..	..	..	×
Buds of Khata labhera.	Labhera ka bor.	Cordia myxa	Locally and other villages ..	×	×	..	..	..	..	..	..	..	..	..	×
Buds of kachnar ..	Kachnar ..	Bauhania variegata ..	Locally	..	..	..	..	..	..	..	..	..	..	..	×
Leafy vegetables															
Wild potherb ..	Nari ..	Ipomoea aquatica ..	Wild in ponds near village ..	..	..	..	×	×	×	×	..	..	..	..	..
	Paintiya ..	(Unable to locate) ..	Wild leaves spread on ground.	..	..	..	..	×	×	×	..	..	..	..	..
A Wild potherb ..	Lissua ..	Triumfetta pilosa(?) ..	Wild in uncultivated areas ..	..	..	..	..	×	×	×	..	..	..	..	..
Potherb	Chaunrai ..	Amaranthus viridis ..	Wild in fields	..	..	..	..	×	×	×	..	..	..	..	..
Radish top ..	Muli ki patti	(*See* radish)	Local vegetable growers ..	..	..	..	..	..	×	×	..	..	..	..	..
White goose-foot ..	Batua ..	Chenopodium album ..	In wheat and barley fields ..	..	..	..	..	..	..	..	×	×	×	..	..
Tops of pea vines ..	Mattar ki patti	(*See* peas)	Fields of village. (Dried April—July).	×	×	×	×	..	..	..	×	×	×	×	×
Gram tops ..	Channa ki patti.	(*See* chick-pea) (gram) ..	Local fields. (Dried April—July).	×	×	×	×	..	..	..	..	×	×	×	×

Foods available in Karimpur, by months—(continued)

English	Name		Sources	When available											
	Local	Botanical		Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Leafy vegetables—(*concld.*)															
Chard	Palak ..	Beta vulgaris ..	Local vegetable growers and those of Mainpuri.	..	..	..	..	..	..	..	..	×	×	..	..
Mustard tops ..	Karari ..	Brassica campestris ..	Local fields. (Dried March—July).	×	×	×	×	..	..	..	..	×	×	×	×
Fenugreek ..	Methi ..	Trigonella foenum-graecum.	Local fields. (Dried April—July).	×	×	×	×	..	..	..	..	×	×	×	×
Dill	Soya ..	Peucedanum graveolens ..	Usually grown with palak ..	..	..	..	..	..	..	..	..	×	×	×	×
Fruit															
Green mangoes ..	Am ..	Mangifera indica ..	Groves, along roadside, around wells. (Pickled or dried after July.)	×	×	×	×	×	×	×	×	×	×	×	..
Wild figs ..	Gular ..	Ficus glomerata ..	Groves of village	×	×	×	×	..	..	..	..	..	..	..	..
Mahua blossoms ..	Mahua ke phul.	Bassia latifolia ..	Ditto	×	×	×	..	..	..	..	..	..	..	..	..
	Bel ..	Aegle marmelos ..	Ditto	×	×	×	×	×	..	..	..	..	..	..	×
Berries of peepal ..	Pipali ..	Ficus religiosa ..	Ditto	×	×	×	×	..	..	..	..	..	..	..	..
Sweet melon. (Like musk melon.)	Kharbuz ..	Cucumis melo ..	Locally and other villages ..	×	×	×	×	..	..	..	..	..	..	..	..
Jack fruit	Kathal ..	Artocarpus integrifolia ..	Groves of the village ..	..	..	×	..	..	..	..	..	..	..	..	..

Jack fruit	Kathal	Artocarpus integrifolia	Groves of the village	..	..	×	..	..	..	..	..	..	..	..	..
Guava	Amrud	Psidium guyava	Few in village. Other villages	..	..	×	×	×	×	×	×	×	×	×	..
Date	Khajur	Phoenix sylvestris	Near village	..	..	×	×	×	×	×	..	..	..	..	..
Date	Chuara	Phoenix dactylifera	Ditto	..	..	×	×	×	×	×	..	..	..	..	..
Margosa berries	Nimori	Melia azadirachta	Trees around village	..	..	×	×	..	..	..	..	..	..	..	..
Banyan	Bargat	Ficus bengalensis	Ditto	..	×	×	×	..	..	..	..	..	..	..	..
Like a plum	Jaman	Eugenia jambolana	Ditto	..	..	..	×	×	..	..	..	..	..	..	..
Pomegranate	Anar	Punica granatum	Groves of village. From bazar	..	..	..	×	×	..	..	..	..	..	..	×
Berries of heens	Hins	Capparis sepiaria	Trees near village	..	..	..	..	×	×	×	..	..	..	..	..
Lime	Nimbu	Citrus acida	Groves of village—few, (Pickled December—April.)	×	..	..	..	..	..	..	×	×	×	×	×
Wood apple	Kait	Feronia elephantum	Groves of village	×	×	×	..	..	..	..	×	×	×	×	×
Wild plum	Jahrberi	Zizyphus rotundifolia	Around village	..	..	..	..	..	..	..	×	×	×	..	..
Tamarind pods	Imli	Tamarindus indica	Groves of village	×	×	×	..	..	..	..	..	..	..	..	×
Indian jujube	Ber	Zizyphus jujuba	Groves and fields	..	..	..	..	..	..	..	..	..	×	×	×
Like plums	Khata labhera	Cordia myxa	Local groves and those of other villages.	..	×	×	×	×	..	..	..	..	..	..	..
Like plums	Rai labhera	Cordia vestita	Chiefly from other villages	..	×	..	..	..	..	..	..	..	..	..	..
Plantain	Kela	Musa sapientum	Groves of village and Mainpuri.	..	×	×	×	×	×	×	..	..	..	..	..
Water melon	Turbuza	Citrullus vulgaris	Local vegetable growers and those of other villages.	..	..	×	×	..	..	..	..	..	..	..	..

Foods available in Karimpur by months—(concluded)

English	Name		Sources	When available											
	Local	Botanical		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Other foods															
	Phapola ..	Nymphoce lotus ..	Grows in ponds near village ..	×	..	..	..	..	×	×	×	×	×	×	×
Water chestnut ..	Singhara ..	Trapa bispinosa ..	Peinds near village ..	..	..	..	..	..	..	×	×	..	..	..	..
Sugarcane ..	Ik ..	Saccharum officinarum ..	Fields of village	..	..	..	..	..	..	..	×	×	×	×	×
Mustard	Sarson ..	Brassica campestris ..	Grows in fields with wheat, barley, or gram.	×	×	×	×	×	×	×	×	×	×	×	×
Rape	Lahi ..	Brassica napus. Var. dichotoma.	In fields, usually alone ..	×	×	×	×	×	×	×	×	×	×	×	×
Mustard	Duan ..	Eruca sativa	Groves as border, or mixed with barley.	×	×	×	×	×	×	×	×	×	×	×	×
Mustard	La or Rai ..	Brassica juncea ..	Border of wheat and barley fields.	×	×	×	×	×	×	×	×	×	×	×	×
Black and white sesamum.	Ti and Tilli	Sesamum indi um ..	In fields with millet or cotton..	..	..	..	..	..	..	×	×	×	×	×	×
Mint	Podina ..	Mentha viridis ..	Court yards	×	×	×	×	×	×	×	×	×	×	×	×

The preceding record tells us what foods our village people eat. And the following diet records give us an idea of how much they eat. We cannot hope to arrive at accurate results, with the equipment of village homes and the preparation of illiterate village housewives. These two drawbacks we could have met. But custom rose up to complicate each step.

To get a representative picture of village food consumption, I thought that we should have records from at least twelve homes each representing a different standard. I could not rely upon the women of these homes to do the recording, as they were not accustomed to measuring their food, and they could not have kept any records of the measurements if they had made them. As was mentioned in connexion with Food Sources, measuring is a casual matter, and is usually comparative—one food balancing another. The two women who could write and whom I could have taught to do the measuring, were kept in strict seclusion within their own courtyards. I had lived in the village long enough to know that my interference in anything related to food would be most unwelcome, even among my best friends. I finally chose three Brahman boys to help in the project. They could write. They were still young enough to be acceptable in any of the homes, and their caste made them doubly welcome. They went into the project very seriously and importantly.

One of the many surprises I had in connexion with it, was the willingness of the women to let the boys write down figures which they themselves could not read. Village men, and still more, village women, have a great fear of written records. In their experience the only exact records have been those kept by Government clerks, rent collectors and grain and money-lenders. As a result they associate recorded figures with oppression. They become restrained at the sight of a note book and pencil. So I learned to make mental notes, to be written down after getting back to our tent. But with the boys, recording took on a different aspect. They flourished their pencils and paper—both rare in the village—and made a great fuss over their measurements and figures. And the women laughed and were willing to humour them. But before the second month was up, their old suspicions were aroused. Some one brought up the question which blocked us repeatedly. Why did we want such figures? They began to imagine that the quantities of food they ate might reveal their status in some way. And this discovery might in turn lead to an increase in taxation. To this road, all paths seemed to lead—fear of increased interest or taxation.

Also, I realized that within certain seasons, the diet is monotonous enough to make records for short periods satisfactory. We waited for a new set of field crops. But in waiting, we missed the wild herbs, and the rainy season vegetables. These may be found in the partial food records for August and September, appended to this chapter. We renewed our weighing and recording in November. One week was found enough to cover that season.

There were still other complications which added to the interest of record-keeping. In our village we have three distinct systems of weights, for those who

aspire to weighing. One is called "kachcha." According to it, one "ser" is 1.4 avoirdupois pounds. The second is called "pakka." According to it, one "ser" is 2.8 avoirdupois pounds. And a third is "sarcari" or "official" amounting to 2.12 pounds. We tried to keep each of our helpers to the system to which he was most accustomed. But they were apt to slip from one to another and back again, without noting the change. This required additional checking.

In the light of these possibilities of error, I make no claims for the dietaries beyond the fact that they are a seriously made estimate of foods eaten in village homes.

The next question we ask is—Do the amounts of these foods eaten meet the needs of the people who eat them. To estimate this, I figured the total daily food allowance necessary for each family, and compared this with the content of the foods eaten by the same family in one average day. The food allowance for each member of a family for a day is calculated according to the suggestions of Edith Hawley. (26). These are then totalled to give the need of the whole family for a day.

Hawley does not include iron. So I have based the allowance for adults on Sherman's "Chemistry of Foods," (27) and that for children is calculated from the amount suggested by Rose and others in a special study of iron intake and output of a girl 31 months old, weighing 31 pounds. They recommend that children two to three years of age receive at least 0.75 milligrams of iron per 100 calories. (28).

The needs of the pregnant women were calculated from figures given by Rose (29). Those of the nursing mother were calculated from suggestions made by Rose in "Feeding the Family. (30)."

(26), (27), (28), (29), (30) See References.

*Foods eaten by a Brahman family of Karimpur during one week of May, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk buttermilk, or curd	Meat	Oil or ghee	Raw sugar or other sweet	Salt
May, 1928	lb. oz.			lb. oz.	lb. oz.		(Milk) qts		(Ghee) lb. oz	lb. oz.	
25	Wheat 7 0	..	..	Pigeon pea. 1 12	Cucumber 2 12	Mangoes 8	1½	..	..	5½	..
26	Wheat 3 8 Barley 3 8	..	..	..	Egg plant 2 2	Mangoes 2	1½	..	0 4	1 0	..
27	Wheat 3 8 Barley 3 8	..	..	Pigeon 1 6	Gram tops 0 12	Mangoes 10	1½	..	..	5½	..
28	Wheat 3 8 Barley 3 8	..	..	Pigeon pea. 1 6	Pumpkin 1 6	Muskmelon 4	1½	..	1 0	5½	..
29	Wheat 3 8 Barley 3 8	..	..	Gram 0 6½	Pumpkin 1 6	Mangoes 4	1½	..	..	6	..
30	Wheat 3 8 Barley 3 8	..	..	..	Pumpkin 2 2	Muskmelon 1	1½	..	0 6	5½	..
31	Wheat 3 8 Barley 3 8	..	..	..	Cucumber 0 8	Mangoes 6	1½	..	..	..	..
Total weight.	Wheat 28 0 Barley 21 0	..	..	Pigeon pea. 4 8 Gram .. 0 6½	Cucumber 3 4 Pumpkin 4 14 Egg plant 2 2 Gram tops 0 12	Mangoes 30 Muskmelon 5	10½	..	1 10	2 12	1 lb. (weekly total.)

*Three men (ages 47, 25, 20).
Two women (ages 17, 15).
One boy (age 9—brother of younger woman).
One infant (age 10 months).
One helper (age 12).

*Food eaten by a Brahman family of Karimpur during one week of November, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk butter-milk	Meat	Oil or ghee	Pickles	Raw sugar or other sweets	Salt
November, 1928.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.				'Ghee' lb.oz.	oz.	lb. oz.	
6	Maize 8 6	Barley 0 3	..	Urd 2 2	Patato 1 6	..	..	..	0 3	3	0 5½	..
7	Maize 3 8 Wheat 4 5	Maize 0 3	..	Mung 1 6	Cauli-flower. 1 6	..	..	..	0 3	..	5½	..
8	Wheat 4 3	Maize 2 12	3 8	Pigeon pea. 1 6	..	..	..	..	..	..	..	..
9 (One hired man).	Wheat 8 6 Maize 2 2	..	..	..	Potato 2 12	..	..	..	..	..	0 5½	..
10	Maize 7 11	Barley 0 12	..	Pigeon pea. 1 6	..	..	..	..	1½	..	0 8	..
11	Wheat 10 8 (Special cakes for festival. Three lbs. given away).	..	..	..	Potato 4 3	..	..	..	2 8	3	1 6	..
12	Wheat 6 5	..	..	..	Potato 2 12 Mustard tops. 0 12	..	..	..	1 0	3 3	..	..
Total weights.	Wheat 33 9 Maize 21 11	Barley 0 15 Maize 2 15	3 8	Pigeon pea. 2 12 Urd 2 12 Mung 1 6	Patato 11 1 Cauli-flower 1 6 Mustard tops. 0 12	..	..	..	3 15½	12	2 14½	1 lb. (weekly total).

*Three men (ages 47, 25, 20).
Two women (ages, 17, 15).
One boy (age 9—brother of younger woman).
One infant (age 10 months).
One helper (age 12).

*Food eaten by a Carpenter Family of Karimpur during one week of May, 1928**

*Three men (ages 47, 25, 20).
Two women (ages, 17, 15).
One boy (age 9—brother of younger woman).
One infant (age 10 months).
One helper (age 12).

*Food eaten by a Carpenter Family of Karimpur during one week of May, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk butter milk	Goat meat	Oil or ghee	Pickles	Raw sugar or other sweets	Salt
May, 1928	lb. oz.	lb. oz.		oz.	lb. oz.				oz.	oz.	oz.	
25	Wheat 2 7 Barley 2 7	..	..	Parched gram. 3	Pumpkin 2 0	Muskmelon 5	..	..	Mustard oil. 4	..	6	..
26	Wheat 2 7 Barley 2 7	..	..	..	..	Muskmelon 4	..	..	Mustard oil. 4	..	..	..
27	Barley 2 7 Peas 2 7	Barley 8	..	Pigeon Pea. 3	..	..	..	..	..	Mangoes 6	5½	..
28	Barley 2 7 Peas 2 7	Barley 8	..	..	Pumpkin 1 6	Mangoes 7	..	..	Mustard oil 4	..	..	..
29	Barley 2 7 Peas 2 7	..	..	..	Pumpkin 1 6	Watermelon 1	..	..	Mustard oil 4	..	..	..
30	Wheat 2 7 Barley 2 7	..	..	..	Pumpkin 1 6	Muskmelon 4	..	..	Mustard oil 4	..	..	..
31	Barley 2 7 Peas 2 7	Barley 12	..	..	Pumpkin 1 12	Mangoes 8	..	..	..	..	5½	..
Total weights	Wheat 7 5 Barley 17 1 Peas 9 12	Barley 1 12	..	Gram 3 Pigeon pea. 3	Pumpkin 7 14	Muskmelon 13 Watermelon 1 Mangoes 15	..	..	Mustard oil. 20	Mangoes 6	17	12 oz. (weekly total).

*Two men (ages 33, 24).
One girl (age 10).
Three women (ages 50, 27, 20).
One boy (age, 4).
One girl (age 3).

*Food eaten by a carpenter family of Karimpur during one week of November, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk, butter-milk	Goat meat	Oil or ghee	Pickles	Raw sugar or other sweets	Salt
November, 1928.	lb. oz.	lb. oz.	lb.oz.	lb. oz.	lb. oz.		Butter milk qts.		lb. oz.	oz.	lb. oz.	
6	Maize 8 6	..	..	Pigeon pea 1 6	..	..	1	..	..	Mango 3	0 5½	..
7	Great millet 7 11	Maize 0 12	..	Pigeon pea 1 6	..	..	..	..	..	..	..	..
8	Maize 7 9	Barley 1 0	..	..	Radishes with tops 1 6	..	..	..	Mustard oil 1½	Mango 3	0 3	..
9	Maize 7 0	Barley 1 0	..	..	Egyptian arum 1 6	..	..	..	..	..	..	..
10	Great millet 7 11	..	Puffed rice 1 6	Pigeon pea 1 6	..	Guavas 5	1	..	..	..	..	..
11 Festival puris.	Wheat 9	..	..	..	Egyptian arum 2 12	..	1	..	Mustard oil 12	Mango 1½	0 12	..
12 More puris	Wheat 7 0	..	..	..	..	..	..	..	Ghee 1 6	Mango 1½	..	..
Total weights.	Maize 22 6 Wheat 16 0 Millet 15 6	Maize 0 12 Barley 2 0	Puffed rice 1 6	Pigeon pea 4 2	Radishes1 6 Arum 4 2	Guaves 5	3	..	Mustard oil 13½ Ghee 1 6	Mango 9	1 4½	12 oz. weekly total).

*Two men (ages 33, 24).
Three women (ages 50, 27, 20).
One girl (age 10).
One boy (age 4).
One child (age 3)

*Food eaten by an oil presser family of Karimpur during one week of May, 1928**

*Two men (ages 33, 24).
Three women (ages 50, 27, 20).
One girl (age 10).
One boy (age 4).
One child (age 3)

*Food eaten by an oil presser family of Karimpnr during one week of May, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk, butter milk	Goat meat	Oil or "Ghee"	Pickle	Raw sugar or other sweets	Salt
May, 1928	lb. oz.	lb. oz.		lb. oz.	lb. oz.			lb. oz.	(Oil) oz.		oz.	
25	Wheat 2 12 Barley 2 12	..	..	..	..	..	..	1 6	3	..	..	..
26	Wheat 2 14 Barley 2 14	..	..	Pigeon pea 0 3	..	..	..	..	..	..	..	..
27	Wheat 1 14 Barley 1 14 Gram 1 14	..	..	Pigeon pea 0 3	..	..	..	..	..	..	..	..
28	Wheat 2 12 Barley 2 12	..	..	..	Gourd 1 6	Mangoes 18	..	..	2	..	12	..
29	..	Roasted barley 1 6	..	Parched gram 1 6	..	Watermelon 2	..	..	..	..	..	..
30	Wheat 1 14 Barley 1 14 Gram 1 14	..	..	Pigeon pea 0 3	..	Watermelon 1	..	..	..	..	..	..
31	Wheat 1 14 Barley 1 14 Gram 1 14	Roasted barley 0 12	..	Pigeon pea 3	..	Watermelon 2	..	0 12	2	..	..	..
Total weights. {	Wheat 14 0 Barley 14 0 Gram 5 10	Roasted barley 2 2	..	Pigoon pea 0 12 Parched gram 1 6	Gourd 1 6	Watermelon 5 Mangoes 18	..	2 2	7	..	12	3 oz. (weekly total)

*One man (age 38).
One girl (age 11).
One woman (age 27).
One boy (age 6).
One boy (age 6 months).

*Food eaten by an oil presser family of Karimpur during one week of November, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk, butter-milk	Goat meat	Oil or ghee	Pickles	Raw sugar or other sweet	Salt
November, 1928							(Butter milk).					
	lb. oz.	oz.		lb. oz.	lb. oz.		Qt.		oz.	oz.	lbs.	oz.
6	Maize 2 12	..		Parched gram 0 12	Radishes with tops. 0 12		1		Mustard oils 1½	..	..	..
7	Maize 2 12	..	..	Pigeon pea 0 12	..	..	..	..	..	..	..	..
8	Maize 2 0	Roasted wheat 5½	..	Pigeon pea 0 12	..	..	..	..	..	..	0 2	..
9	Maize 4 3	..	..	..	..	..	..	..	..	..	..	..
10	Spiked millet 4 3	Parched corn. 5½	..	..	Spinach 1 6	..	1	..	..	Mangoes 2	..	..
11 (festival).	Wheat 5 9	..	..	Parched gram 0 12	Egyptian arum • 2 0	..	..	..	Mustard oil 12 Ghee 12	..	1 0	..
12	Wheat 2 0	..	..	Urd 0 8	..	..	..	..	..	Radish 3	..	..
	Maize 2 12											
Total weights	Maize 14 7 Wheat 7 9 Spiked millet. 4 3	Parched corn 5½ Roasted wheat 5½	..	Pigeon pea 1 8 Parched gram 1 8 Urd 0 8	Radishes 0 12 Spinach 1 6 Arum 2 0	..	2		Mustard oil 13½ Ghee 12	Mangoes 2 Radish 3	1 2	3 (weekly total).

*One man (age 38).
One woman (age 27).
One boy (age 6 months).
One girl (age 11).
One boy (age 6).

*One man (age 38).
One woman (age 27).
One boy (age 6 months).
One girl (age 11).
One boy (age 6).

*Food eaten by an outcaste family of Karimpur during one week of May, 1928**

Date	Cereal in bread		Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk, butter, milk	Meat	Oil or "ghee"	Pickles	Raw sugar or other sweets	Salt
May, 1928		lb. oz.			lb. oz.	lb. oz.		(Buttermilk).	oz.		oz.		oz.
25	Wheat	2 12	..	..	..	Pumpkin 0 12	Mangoes 6	½ qt.	..	..	..	..	..
26	Wheat Barley	1 6 1 6	..	..	..	..	Mangoes 4	..	..	..	3	..	..
27	Wheat Barley	1 6 1 6	..	..	..	..	..	..	12	..	..	..	..
28	Wheat Barley	1 6 1 6	..	..	Pigeon pea, 0 12	..	..	..	..	..	..	..	..
29	Wheat Barley	1 6 1 6	..	..	Pigeon pea 0 12	..	Mangoes 6	..	..	..	..	..	..
30	Wheat Barley	1 6 1 6	..	..	..	Pumpkin 1 6	..	..	..	..	..	..	..
31	Wheat Barley	1 6 1 6	..	..	..	Pumpkin 1 6	Mangoes 4	..	..	..	..	..	..
Total weights.	Barley Wheat	8 4 11 0	..	..	Pigeon pea 1 8	Pumpkin 3 8	Mangoes 20	½ qt.	12	..	3	..	4½ (weekly total).

*One man (age 22).
One woman (age 50).
One woman (age 18).
One boy (age 3).

*Food eaten by an outcaste family of Karimpur during one week of November, 1928**

Date	Cereal in bread	Parched cereal	Rice	Split pulse	Vegetables	Fruit	Milk, butter-milk.	Oil or ghee	Pickles	Raw sugar or other sweets	Salt
November, 1928.	lb. oz.	oz.		lb. oz.	lb. oz.		(Butter-milk). qt.	lb. oz.	oz.	oz.	oz.
6	Great millet 2 12	..	..	Pigeon pea 0 8	..	..	1	..	Mango 1½	..	..
7	Great millet 2 12	Barley 5½	..	Pigeon pea 0 8	..	..	..	..	..	..	..
8	Maize 3 8	..	..	..	..	..	1	..	..	1½	..
9	Maize 3 2	..	..	Pigeon pea 0 12	..	..	..	..	Mango 1½	..	..
10	Maize 3 2	..	..	Pigeon pea 0 12	..	..	..	..	..	..	..
11 (festival)	Wheat 2 12	..	..	..	Radishes with tops 1 6	..	..	Mustard oil 0 12	Mango 3	8	..
12	Wheat 3 8	..	..	..	..	..	1	Mustard oil 0 12	Mango 3	3	..
Total weights.	Wheat 6 4 Maize 9 12 Great millet 5 8	Barley 5½	..	Pigeon pea 2 8	Radishes with tops 1 6	..	3	Mustard oil 1 8	Pickles 9	12½	5 (weekly total).

*One man (age 22).
One woman (age 50).
One woman (age 18).
One boy (age 3).

The content of the foods eaten had to be based on analyses of the same or similar foods in the West. I realize that their application to foods grown, stored and prepared in homes of North India, can only be an approximation. The food tables in Rose's Laboratory Manual, third edition, 1929, and Sherman's Chemistry of Foods, third edition, 1930, were my chief references, supplemented by Bulletins of the United States Department of Agriculture and of Hawaii.

The calories, carbohydrate, fat, protein, calcium, phorphorus and iron contained in the total amount of each separate food eaten by a family during the week were found. These constituents were then totalled (from all foods eaten during the week) and divided by seven, to get the daily average for the family.

These tables with their requirements based on the comparatively low weights of our village people, imply that the foods which they are getting are adequate, except in calcium. But as we compare their physique with that of the Sikhs, admired by McCarrison, we know that they are low in weight and height. A review of each food constituent may help explain the lack.

Calories—According to the figures estimated, calories are more than sufficient for the oil-presser family, and very nearly adequate for the others, except the carpenters. These calories come chiefly from carbohydrates and protein, which implies that an unusually large amount of both of these must be consumed. Their chief sources are cereals and pulses. The figures for cereals consumed are based on five-sixths of the quantity recorded as being taken out of the store-rooms by the women. We found in a number of experiments with toasted cakes that from

A comparison of nutritive needs with food consumption of a Brahman family in Karimpur

——	Calories	Weights in grams			
		Protein	Minerals		
			Ca.	P.	Fe.
Total amounts needed daily	16,609	422.7	4.600	6.972	.104
Total amounts consumed daily (May, 1928)	13,855	466.8	3.699	13.216	.144
Total amounts consumed daily (November, 1928).	16,865	440.66	2.227	11.539	.120

*One man (age 22).
One woman (age 50).
One woman (age 18).
One boy (age 3).

Estimated daily needs of individual members of family. Total need is based on these figures

—	Weight in lb.	Calories	Weights in grams			
			Protein	Minerals		
				Ca.	P.	Fe.
One man (age 47 years) ..	110	2,310	49·5	·550	·990	·015
One man (age 25 years) ..	105	2,205	47·3	·525	·945	·015
One man (age 20 years) ..	115	2,415	51·7	·575	1·035	·015
One woman (age 17 years) lactating.	90	2,530	68·0	·787	·970	·018
One woman (age 15 years) pregnant.	85	1,985	45·0	·675	·800	·018
One baby girl (age 10 months)	16	..	..	..	..	..
One boy (age 9 years) ..	54	1,944	70·2	·648	·972	·018
One helper (age 12 years) ..	70	3,220	91·0	·840	1·260	·015
Total ..	..	16,609	422·7	4·600	6·972	·104

A comparison of nutritive needs with food consumption of carpenter family of Karimpur

—	Calories	Weights in grams			
		Protein	Minerals		
			Ca.	P.	Fe.
Total amounts needed daily ..	13,230	366·9	4·075	6·725	·097
Total amounts consumed daily (May, 1928.)	7,838	297·3	1·534	7·118	·0924
Total amounts consumed daily (November, 1928.)	12,878	364·5	1·5209	7·005	·0771

Estimated daily needs of individual members of family. Total need is based on these figures

—	Weight in lbs.	Calories	Weights in grams			
			Protein	Minerals		
				Ca.	P.	Fe.
One man (age 33 years) ..	110	2,310	49·5	·550	·990	·015
One man (age 24 years) ..	105	2,205	47·3	·525	·945	·015
One woman (age 27 years) ..	90	1,890	40·5	·450	·810	·015
One woman (age 50 years) ..	85	1,785	38·3	·425	·760	·015
One woman (age 20 years) ..	95	1,995	42·8	·475	·855	·015
One boy (age 4 years) ..	30	630	42·0	·540	·750	·006
One girl (age 3 years) ..	25	525	35·0	·450	·625	·006
One girl (age 10 years) ..	55	1,890	71·5	·660	·990	·010
Total ..		13,230	366·9	4·075	6·725	·097

A comparison of nutritive need with food consumption of an oil pressure family of Karimpur

—	Calories	Weights in grams			
		Protein	Minerals		
			Ca.	P.	Fe.
Total amounts needed daily ..	6,606	196·4	2·148	3·420	·037
Total amounts consumed daily (May, 1928).	8,325	325·85	·993	8·399	·0942
Total amounts consumed daily (November, 1928).	7,479	231·14	1·795	6·441	·0658

Estimated daily needs of individual members of family. Total need is based on these figures

—	Weight in lbs.	Calories	Weights in grams			
			Protein	Minerals		
				Ca.	P.	Fe.
One man (age 38 years) ..	100	2,100	45·0	·500	·900	·015
One woman (age 27 years) ..	80	2,160	36·0	·400	·720	·015
One girl (age 11 years) ..	50	1,050	65·0	·600	·900	·010
One boy (age 6 years) ..	36	1,296	50·4	·048	·900	·009
One boy (age 6 months) ..	12	..	..	..	..	..
Total ..	..	6·606	196·4	2·148	3·420	·037

A comparison of nutritive needs with food consumption of an outcaste family of Karimpur

—	Calories	Weights in grams			
		Protein	Minerals		
			Ca.	P.	Fe.
Total amounts needed daily ..	6,816	162·5	1·868	3·165	·050
Total amounts consumed daily (May, 1928).	4,468	170·19	·714	4·690	·039
Total amounts consumed daily (November, 1928).	5,985	180·8	·862	3·658	·0312

Estimated daily needs of individual members of family. Total need is based on these figures

—	Weight in lbs.	Colories	Weights in grams			
			Protein	Minerals		
One man (age 22 years) ..	105	2,205	47·3	·525	·945	·015
One woman (age 50 years) ..	85	1,785	38·3	·425	·760	·015
One woman (age 18 years) ..	90	1,890	40·5	·450	·810	·015
One boy (age 3 years) ..	26	936	36·4	·468	·650	·005
Total ..	..	6,816	162·5	1·868	3·165	·050

every three pounds of grain taken out to be used, eight ounces are lost in grinding and cleaning. The loss in the case of pulses was not recorded. In the Brahman home, the pulses are soaked and the husks removed, but in poorer homes, the whole pulse is usually cooked.

The daily average of carbohydrates recorded as having been eaten by our four village families are as follows:

Carbohydrates in dietaries of four Karimpur families

Family	Month	Daily average (grams)	Per cent. of total calories (daily average) in form of carbohydrates
Brahman	May	2,487.67 g.	72
	November	2,874.22	72
Carpenter	May	1,385.50	71
	November	2,397.38	75
Oil-presser	May	1,371.80	75
	November	1,311.60	70
Outcaste	May	868.4	78
	November	1,013.3	68

McCay in his jail investigations made a study of co-efficients of absorption of carbohydrates. His table is as follows:

Wheat	(23 oz.)	96.5 %	absorbed.
Barley	(23 oz.)	96.0 %	"
Great millet		97.8 %	"
Spiked millet		97.8 %	"
Gram	(5 oz.)	97.7 %	"
Pigeon pea		96.8 %	"

Of fats, McCay says, "We have made no investigations on the absorption of fats of the jail dietaries of the United Provinces. The quantity of fat in these diets is very small and did not appear of sufficient importance to warrant special enquiry." (31).

Our figures for the average daily amount of fats used are as follows:

(31) See References.

Fats in dietaries of four Karimpur families.

Family	Month	Daily average (grams)	Per cent. of total calories (daily average) in form of fats
Brahman	May	222.34	14
	November	239.56	15
Carpenter	May	110.95	13
	November	201.28	14
Oil-presser	May	86.50	9
	November	141.19	17
Outcaste	May	30.65	
	November	126.45	19

The larger amount consumed by all families in November is due to the advent of a special festival. Wheat and *ghee* were substracted from the original figures of the Brahman family, to allow for cakes distributed to dependants. A lesser amount of wheat and mustard oil was substracted from the figures given by the carpenter, as they too have begging callers at this time. But after these amounts have been deducted, the festival figures still stand high.

The Brahmans of the village are reputed as using more *ghee* than others. This may be accounted for by their comparative prosperity, and by the greater demand for "pakka" food among them. This is discussed under Food Practices.

In most proposed dietaries, the calories furnished by protein are listed separately, whereas those of fats and carbohydrates are lumped together. Lusk has collected standard dietaries, a study of which may be useful.

> "The 'standard' dietaries are given below, not because they are inflexible requirements in any sense of the word, but merely for the convenience of the reader. The individual standard will ever be controlled by climate, the amount and kind of mechanical effort, by appetite, purse and dietetic prejudice."

Standard dietaries for a man of 70 kilograms.
(Weights in grams)

	Voit	Rubner
Light work—		
Protein		123
Fat		46
Carbohydrates		377
Calories		2,445
Medium work—		
Protein	118	127
Fat	56	52
Carbohydrates	500	509
Calories	3,005	2,868
Hard work—		
Protein	145	165
Fat	100	70
Carbohydrates	500	565
Calories	3,574	3,36,232 [as in original]

The calorie make-up of our village dietaries, compare with these standard dietaries as follows:

Constituent	Per cent. of total calories		
	Voit	Rubner	Karimpur (May)
Protein	15—17	18—20	14—16
Fat	16—25	16—19	6—14
Carbohydrates	65—67	62—71	71—78

According to this, our village diets are high in carbohydrates, while protein, and especially fat, are low. This is what we might expect when cereals are used so extensively, and when proteins come from vegetable rather than animal sources.

Protein—In writing of protein standards for family dietaries Sherman states, "To allow for varying conditions and for individual preferences as well as to provide a liberal margin for safety it is customary to consider that from 10 to 15 per cent of the total calories may be in the form of protein." (33). The daily average of protein in our tables is as follows:

(33) See References.

Protein in dietaries of four Karimpur families

Family	Month	Daily average (grams)	Per cent. of total calories (daily average) in form of protein
Brahman	May	466.8	14
	November	440.7	13
Carpenter	May	297.3	16
	November	364.5	11
Oil-presser	May	325.9	16
	November	231.14	13
Outcaste	May	170.19	16
	November	180.80	13

Although the protein according to figures in the record of food consumed appears to be more than the amount needed, with one exception (the carpenter family in May), it does not exceed the percentage of calories suggested as correct by Sherman (10 to 15 per cent.).

McCay (34) gives the following table of percentage absorption of proteins of the food materials in use in the jail dietaries of the United Provinces.

Food stuff	Absorption of protein
Wheat	67.10
Arhar "dal" (pigeon pea) plus vegetables	80.50
Arhar "dal" (pigeon pea) alone	81.84
Gram "dal" (split gram)	64.20
Barley	57.60
Juar (great millet)	53.00
"Urd"	69.20
"Bajra" (spiked millet)	49.40

From this he concludes: "It cannot be for the welfare of the body that an average of 34 grams of protein daily should remain incapable of absorption, which, while in the bowel, provides a splendid culture medium for the growth of putrefactive micro-organisms." (35).

He comments on the importance of the methods of treatment of foods, especially the split pulses, in relation to their absorption. "Gram dal, for instance,

(34), (35) See References.

is usually given as a morning meal in the form of parched gram, i.e. simply fried or heated until the greater part of the contained moisture is got rid of; no steps whatever are taken to break up the grains so that the digestive juices may have a proper opportunity of carrying out their work satisfactorily. Investigations on the absorption of pea and lentil flour, properly cooked, show that the protein is all taken up except about 8 to 9 per cent. If, however, the pulse is not given in a state of fine division, the loss of protein has been found to rise to 40 per cent." (36).

Not only must the absorption of proteins be considered, but also their ability to meet body needs after absorption. This ability apparently depends upon the amino-acids which the proteins yield on digestion. Therefore, "It seem logical to prefer to serve the needs of the body by providing it with the optimal amount of such proteins as can be utilized very effectively rather than to require it to digest and assimilate an excessive amount of proteins of low value." (37).

A group of Indians are undertaking a study of the pulses which are the chief sources of protein in the Indian diet. Their first study was that of the globulins of the pigeon pea and field pea, both of which are used in our village. They conclude that "Both the globulins compare favourably with casein and contain requisite amounts of arginine, histidine, and lysine. The arginine content of both the globulins is higher than that of casein, being nearly double in the case of the globulin of Pisum arvense field pea. The two globulins are, however, very deficient in both cystine and tryptophane. These legumes are usually taken with cereals and are useful in supplying the essential *diamino* acids especially lysine in which cereal proteins are usually deficient." (38).

Later they studied the values of the lentil (lens esculenta), cow pea (vigna catjang), the aconite bean (the "moth" of our village). They found that all three pulses contain lysine, histidine, arginine, cystine, tyrosine and tryptophane. Their comparison of their utility is: "The analysis of the three globulins shows that the globulin of lens esculenta is characterized by its higher content of lysine and arginine. The net protein values

$$\frac{\text{content of digestible protein} \times \text{biological value}}{100}$$

of the pulse calculated from the metabolism data are given in the following table:

Pulse	Total Protein (N × 6.25)	Net Protein value
	Per cent.	Per cent.
Lens Esculenta	28.74	12.86
Vigna catjang	26.52	11.05
Phaseolus aconitifolius	27.09	9.04

(36), (37), (38) See References.

At a 10 per cent. level of intake, the proteins of lens esculenta are highly digestible while those of vigna catjang have a high biological value. Phaseolus aconitifolius is poor in both respects." (39).

It is interesting that the aconite bean ("moth") is very little cultivated by our people. They seem to keep it especially for invalids. Lentils are not common in Karimpur.

McCollum and Simmonds contribute experimental evidence on the possibility of vegetarian diets. They state that in their own earlier experiments and those of Slonaker, vegetarian rats "grew to about half the size and lived half as long as did their fellows receiving animal food." (40).

Later, McCollum and Simmonds found that it was necessary to introduce a very large quantity of leafy vegetables into a diet of seeds and legumes, to induce normal growth and development in omniverous animals. Their most satisfactory combination was, "maize 50, alfalfa leaf (dry) 30, and cooked dried peas 20 per cent. The ingredients were ground together so that these proportions were eaten." (41). Their conclusion is: "It is possible that better mixtures of vegetable foods may be found, but these results show definitely that for the omniverous type of animal, whose digestive tract is small, the consumption of sufficient volumes of leafy foods is impossible." (42).

In regard to the effect of a purely vegetarian diet on men they conclude that, "It is possible to make a fairly satisfactory diet of foods derived entirely from vegetable sources, but it is not easy to do so. It would be difficult for man to eat enough leafy foods to enable him to succeed with a strictly vegetarian diet. Such a diet will generally be low in protein." (43).

Our village people supply the necessary protein from the pulses, or legumes. But a more successful diet has been worked out by the Sikhs and others further North, who occasionally eat meat and eggs, and drink large quantities of milk. The success of the Sikhs is in agreement with the suggestion of McCollum and Simmonds. "When one adheres to such a regimen (vegetarianism) the addition of small amounts of meat will be valuable, and eggs, because of their relative richness in vitamins A and B, will often be a more effective supplement. The same may be said of glandular organs." (44). The close of their discussion is interesting from the point of view of our study.

"Many of the people of China and Japan, because of poverty and overcrowding, can afford only small additions of fish, poultry, eggs, or the flesh of mammals to a diet which consists in great measure of vegetable foods. From an early age the children are schooled to eat large amounts of leafy vegetables. Many weeds are eagerly sought after and trees are stripped of their buds in spring to supplement the supply of spinach, cabbage, and other leafy foods." This might almost have been written of our village. It explains the gathering of wild potherbs and the picking of tops of growing plants as well as the eagerness for buds of plum trees.

(39), (40), (41), (42), (43), (44) See References.

Repeated studies have shown that whereas proteins of plant origin may be adequate for full-grown adults, they do not contain all of the amino acids which must be supplied in the building of strong new bodies, and they are therefore not sufficient for growing children. Children should have the protein of milk or milk products, and other animal proteins if possible.

Calcium and phosphorus—Calcium is the most consistent deficiency shown in our comparison of food needs and food consumption. Calcium in the Brahman family is higher in May than in November. They also had milk during May, and not in November. The oil-presser's calcium rises in November along with the addition of two quarts of buttermilk. In the outcaste family there was a similar increase in calcium with the addition of milk.

Our American dentist in India told us that there was a deficiency of calcium in the milk of Indian cows and buffaloes. He prescribed calcium lactate for our children.

My own experience with teeth and pregnancy has caused me to wonder about calcium in Indian foods. There seems to be no lack of phosphorus. I lost two teeth with each new baby. I realized that it must be that my own body calcium was being used to build the baby's bones and drank quantities of milk to renew the supply. If I, with over a quart of milk a day, suffered from calcium shortage or from improper balance of calcium and phosphorus, the condition of village mothers should be worse. And it is. They suffer greatly with their teeth, and of course have never heard of a dentist.

The cereals are secondary sources of calcium, and become important because of the large quantities in which they are eaten. Raw cane sugar also supplies calcium. And it is the only sugar used in the village. In the absence of definite information I have credited *ghee* with an amount of calcium equivalent to that in butter. But I feel sure that it should be less, as some calcium must be lost with the protein which, separated during long cooking, is strained off.

Phosphorus—It is apparent from our figures that we need not be concerned over a shortage of phosphorus in the diet. The cereals and pulses supply it in generous amounts. But we cannot count on American figures to represent accurately the amount of phosphorus in Indian foods. This is one element which is known to vary in different soils.

Our chief interest in phosphorus is in its relation to calcium in the work of bone-building. The village children apparently get plenty of phosphorus, but their calcium is deficient. This increases the importance of sunshine in maintaining a proper balance between the two. This will be discussed further, in connexion with Vitamin D.

Iron—Of the several surprises which came to me from the comparison of the needs and the foods consumed in the village, the greatest was the iron. I expected to find a striking deficiency here. But deficiency appears only in the carpenter family in November, and the outcaste family in both May and November.

Here again, as with phosphorus, the cereals and legumes are important. "Most of these grains (wheat, barley, millet, maize, rice) are eaten whole; they are not subjected to any milling or refining process before use. The outer layers of the grain and embryo, containing valuable dietary constituents, are thus consumed with the endosperm." (45).

This use of the whole grains is important to people who are near the margin of deficiency of minerals, especially iron. The green foods which supply our people with iron are not prominent either in May or November. The oil-presser managed to get some spinach. Potatoes appear, in the Brahman family in November, and raw sugar appears in every family as a source of iron.

But with iron as with other food elements, we cannot base our conclusions as to its utilization on figures representing its appearance in the foods we eat.

"Recent research shows that the percentage of iron contained in a food is not by itself an adequate measure of the value of that food in meeting the iron requirement of the body." (46).

Experiments with different food combinations reported by Sherman have shown different degrees of assimilation of the iron. He points out that further research will be necessary before these variations in iron values from equivalent iron contents can be explained.

Vitamins—The prevalence of eye infections prepares one for a deficiency of Vitamin A. And a study of the foods eaten shows that a deficiency exists. We do not know just how much A is lost in the heating of milk, its churning and standing and final long heating in the preparation of *ghi*. According to McCollum and Simmonds A is readily oxidized at higher temperatures, but is relatively stable under conditions generally maintained in the cooking of foods. (47). However, the supply of A from milk is not what we might count on in an American village where butter is used in place of *ghi*. Mustard oil is not an efficient source of A, as A is absent or present in but traces in fats or oils of vegetable origin. Moreover, the percentage of total fat in the diet is low.

Carrots are a possible source of Vitamin A. A report on a study of carrots made by Bills and McDonald showed that the most highly coloured carrots contained 9.6 mg. carotene per 100 g. White varieties contained only about one-eightieth of this amount. (48).

The thin, green leaves of plants have been found to be richer in A than the thicker or whiter leaves. This may help to explain the popularity of the tender tips of leguminous plants.

Vitamin B is supplied by the cereals and pulses which our people eat in abundance. Fortunately it is not harmed in drying and not easily destroyed in cooking. McCarrison demonstrates by experiment the high value of wheat, and the almost equal value of great millet and spiked millet, in Vitamin B as compared with rice. (49). The amount of B which village people get in their cereal flour is greater

(45), (46), (47), (48), (49) See References.

than that of the town dwellers who pride themselves on their thin cakes, made of white flour.

In vitamin B as in A, the leafy vegetables, including mustard greens, make a small contribution. Meat can only be reckoned as a source of vitamins in a few cases.

There is little chance of getting a satisfactory supply of B_2 for the women and children, since the men drink most of the butter-milk. They refuse meat, and the idea of yeast is repulsive to them. Indian mothers see the growth of our children and ask why they grow so much faster and are so much more vigorous than village children. Vitamins may be the answer.

We have talked in terms of vitamin C during the past few years. But long before it was called this, an antiscorbutic value was attributed to foods containing it. As has been mentioned, the tamarind was regarded as an antiscorbutic food, in ancient Sanskrit medicine. McCay in his investigations quotes the rules from the jail code, made before 1911. "1061.—Between the first of April and the first of November when the supply of antiscorbutic vegetables is very indifferent, provision should be made for the daily issuance of an allowance of lime-juice, tamarind pulp, or amchur (dried green mangoes) to each prisoner." (50).

Mangoes are probably our most important available source of C. The following report promises further information on its potency. Several varieties of mango were studied.

"The pulp of the "Alphonso" is stated to be one of the most potent known sources of vitamin C and compares favourably with lemon juice, while "cawaije Patel" is only slightly less active. The 'shundrya' variety is comparatively poor.

"The vitamin A content of the pulp of all three varieties is comparable with that of butter. The "Alphonso" variety was found to be rather better than the other two." (51).

Not knowing what variety of mangoes we have, we hardly know what this study may mean to our village. But it promises further helpful information.

A study of the vitamin C content of Indian food-stuffs made in the nutrition research laboratories, Coonoor, in 1935, adds certain other foods to the list of sources of vitamin C. Among the foods available in our village, which supply vitamin C, they would include ripe gauvas, amaranth leaves, green mango pickle (tender, preserved in salt), green chillies, coriander leaves, cabbage (fresh inner leaves), bitter gourd, cauliflower, spinach (fresh), and turnip. Long standing, or cooking in an open vessel endangers the vitamin C.

Our village babies get less vitamin C than their elders. Many babies have been brought to me who seem similar to those described by McCollum thus: "The baby may become pale, lose its appetite and cease to gain. This condition has been termed 'latent scurvy,' and is more to be feared today than the florid, acute form." (52).

(50), (51), (52) See References.

With the balance between calcium and phosphorus as doubtful as it is in our village, vitamin D becomes especially important. No one in the village buys cod-liver oil, as it is too expensive. Fortunately for our children, they are generously supplied with D through exposure to sunshine. We are not certain of the optimal content in the diet of calcium and phosphorus, but we do know that "when the skin is irradiated with light containing a suitable content of ultra-violet rays, normal calcium and phosphorus metabolism will be maintained, even when the proportions of the bone-forming elements are unfavourable." (53). This refers to unfavourable proportions, but may not apply in case there is actual shortage of calcium or phosphorus.

In surveying the foods eaten by the people of Karimpur, in relation to their needs, we are aware of deficiency, but not any one specific deficiency. We know that the men are not as large, and have not as much resistance to infection as their countrymen, the Sikhs. We know that the women and children are not suffering from any striking illness caused by absence of certain food elements, but they are not as strong as they should be. Figures do not demonstrate many conspicuous faults in the diet. And yet we know that there is not the highest degree of nutrition which might be obtained from the foods available. Rainy Season diets—not analyzed.

*Diet of a Brahman family in Karimpur**

Date	Cereal in bread		Split pulse		Vegetables		Milk, butter-milk	Salt
August, 1927		lb.		lb. oz.		lb. oz.	(Butter-milk) qt.	oz.
13	Wheat . .	14	. .		Gourd . .	5 8	2	. .
14	" . .	7	Field peas	3 6	. .		2	. .
	Barley . .	7						
15	Wheat . .	7	Mung . .	2 13	. .		. .	. .
	Barley . .	1						
16	Wheat . .	14	Pigeon pea	1 6	. .		. .	. .
17	" . .	7	Urd . .	1 6	. .		. .	. .
18	" . .	7	Urd . .	2 13	Mushrooms	0 12	. .	. .
	Barley . .	7						
19	Wheat . .	14	. .		Egypt arum	2 13	2	16
					Gourd . .	1 6		

*Three women, three men, three children.

(53) See References.

*Diet of a farmer family in Karimpur**

Date	Cereals		Vegetables		Milk buttermilk	Fruit	Salt
August, 1927		lb. oz.		lb. oz.	(Buttermilk) qt.	(Dried mango) oz.	oz.
13	Wheat	.. 4 4	Gourd	.. 1 4	1½	..	..
14	Barley	.. 4 4	Mushroom	.. 0 12	1½	..	..
15	,,	.. 4 4		..	1½	12	..
16	,,	.. 4 4	Mushroom	.. 0 12	1½	..	..
17	,,	.. 4 4		..	1½	..	..
18	,,	.. 4 4		..	1½	..	..
19	,,	.. 4 4	Gourd	.. 1 4	1½	..	8

*Two men, one woman, one child

Diet of an outcaste family in Karimpur†

Date	Cereal		Split pulse (field pea)	Vegetable		Sweet	Salt
August, 1927		lb. oz.	lb. oz.		lb. oz.	lb. oz.	lb. oz.
13	Wheat flour	6 0	..	Egypt arum	2 0	..	..
14	Ditto	.. 7 0	..	Mushrooms	0 12	..	..
15	Barley flour Field pea flour Chick pea flour	2 5 2 5 2 5	..	Wild potherb (nari).	1 6	..	..
16	Wheat flour Barley flour Chick pea flour	2 5 2 5 2 5	1 6	..		..	..
17	Barley flour Field pea flour Maize flour	2 12 2 12 1 6	..	..		..	
18	Wheat flour Barley flour Chick pea flour	2 5 2 5 2 5	..	Wild potherb (nari).	1 6		..
19	Wheat flour	7 0	..	Wild potherb (nari).	1 6	1 2	0 12

†Three men, one woman, two children.

Diet of a Muhammadan family in Karimpur (Most of the food for this particular family is begged from Brahman farmers)*

Date	Cereals		Split pulse	Vegetables		Meat	Salt
August, 1927		lb. oz.	oz.		lb. oz.	lb.	oz.
13	Wheat	3 8	..	Egypt arum	0 12	..	..
14	„ ..	1 2	..	Wild potherb (nari).	0 12	..	..
	Barley	1 2					
	Chick pea	1 2					
15	Barley	1 10	..	Egypt arum	0 12	..	..
	Peas ..	1 10	..				
16	Wheat	3 8	..	Wild potherb	0 12	..	..
17	„ ..	1 10	Pigeon pea. 5½.	..		..	
	Barley	1 10					
18	„ ..	1 10	..	Egypt arum	0 12	..	..
	Peas ..	1 10					
19	Wheat	3 8	..	..		2	5

*Two men, one woman, one child.

VI—CONCLUSION

RECOMMENDATIONS

Several years ago an English deputy commissioner set out to improve conditions in a whole government district, not far from ours. His faith was great. In the record of his work he writes, "The secret of all success in the villages is propaganda, and the campaign that has been going on for the last seven years has been wonderfully successful."

"Things undreamt of before, things supposed to be utterly opposed to every custom and sentiment, have come to pass easily and naturally, all owing to continuous and intensive propaganda." (54).

If my confidence were as great as his, I would go first to the village elders, and then to the mothers, with the suggestions which follow.

To the elders I would suggest:

(1) Start orange groves, like those in Kaimganj, fifty miles away.

(2) Replace the old mango trees with new ones.

(3) Grow more potatoes.

(4) Learn from the co-operative society in Fatehgarh, forty miles away, how to store potatoes.

(5) Allow the vegetable growers to raise tomatoes.

(6) Advise the vegetable growers to add more leafy vegetables such as cabbage and chard to their crops.

(7) Get information from the Mainpuri Government experiment farm, on how to get a better milk supply. We have made our contribution to this by securing a high grade bull from the provincial government.

(8) Pass a ruling that fruits must not be picked, or knocked off of trees, until they are ripe. Explain to the men and boys that they will get more from the larger ripe fruit.

If I could find mothers willing to forget custom, I would advise them as follows:

(1) Use wheat for the children as far as possible, and keep the millets and barley for festivals and adult visitors.

(2) If there is little wheat, it is better to mix some of it with other cereals rather than use it up and then give the others, such as millets, alone.

(3) Grind all flour finer for the smaller children, and sift it through coarse cloth as you do now, for festival cakes.

(4) Use pigeon pea in preference to other pulses. Use the others occasionally, for variety, preferably "mung" or "urd."

(54) See References.

(5) Do more than split the pulses. Break them up with the light mill. Or better still, soak the pulse for one day and night; spread it out in a shady corner of the courtyard and keep it covered with a damp cloth until it sprouts. The children will like it.

(6) Ask husbands to give the children more of the buttermilk.

(7) Or give each child a glass of the fresh milk each day. Give each one two or three glasses, if possible. This takes for granted that there is a milk animal—as there is in most homes.

(8) On days when there is milk for the children, give them less pulse.

(9) Rather than fry cakes in "ghi" for the children, toast the cakes and spread them with fresh butter.

(10) If the butter used means a shortage of "ghi", mustard oil can replace the "ghi" for most purposes.

(11) Get eggs, if possible, so that each child will have one or two a week, and gradually increase to four or five a week.

(12) Cook potatoes at least four times a week, if possible. They may be combined with other vegetables and cooked as at present.

(13) Use dasheen (Egyptian arum) during the months when potatoes are not in season.

(14) Cook whatever vegetable is in season, along with potatoes or dasheen. Most vegetables require less cooking than potatoes, and can be added later in the cooking process.

(15) Let the children eat raw carrots, potatoes and cucumbers when there is no cholera in the district.

(16) Try drying carrots, by slicing them thin and spreading them in the sun—as mangoes are dried. Use them in vegetable mixtures when gourds and pumpkins are the chief vegetables in season.

(17) Have a green vegetable at the meal when "kachcha" food can be most easily served. The children can gather fresh potherbs in the rainy season and early fall; and fenugreek and the green tops of peas, gram and mustard plants in the late fall and winter. These same leaves can be dried for the spring, and supplemented with fresh radish tops.

(18) Let the children gather and eat each fruit in its season but encourage them to let the fruit ripen, at home in the sun if not on the trees.

(19) When husbands go to the bazar, ask them to bring home oranges in season, or tomatoes, if they are cheaper.

(20) Plan the children's and your own meals something like this:

Morning—Left-over cakes of wheat or mixed flour, or "satua" (parched cereal) ground finer than for the men. Milk or buttermilk with either one. Allow at least 1 pao (1 cup) for each of the children. Fruit, if there is any.

Noon—Fresh cakes of wheat or mixed flour. Vegetables,—potato and one other. Pulse broken up and cooked thoroughly, with mango, fresh or dried, to flavour it. Or sprouted pulse.

Night—Cakes left from noon, with green vegetable cooked in usual way, one cup of milk or buttermilk for each of the children.

(21) Set regular meal hours for the children and yourselves, as for the men. Ask the children to bring home the eatables they collect from the fields and groves, and share them with you at meal time.

(22) Let them play in the sunshine as they do now, with as few clothes as they now wear.

For the mother of a new baby, I would add the following:

(1) Nurse him for two years, if you want to, and if neither you nor he loses weight begin supplementing your milk with goat's or cow's milk, when he is about a year old, so that he will accept it when your milk is insufficient.

(2) Eat the same kinds of food that you prepare for the children but eat more of them and drink milk if you can possibly get it. You are feeding the baby as well as yourself.

(3) If the baby shows no gain in weight, or cries a great deal, start giving him other food, gradually.

(4) Do not feed him whenever he cries, but try to feed him four times each day, when the shadows are at the same place.

(5) When you start giving him other food do it gradually, beginning with boiled goat's milk diluted with water. You can give him some of the rice water which you drink. Put a little partly ground wheat in a small kettle if you have it, and let it stand beside the milk that is simmering. When it has cooked several hours, strain it and give the liquid to him. When he is about a year old, you can give him some of the potato and other vegetable which you cook, before adding the spices. Mash the vegetable with your cooking spoon. Give him some of the liquid from the green leaves which you cook, before adding spices. Let him have a taste of the egg-yolk prepared for one of the older children. As he gets used to it, add more, until he has one yolk each day. When he has plenty of teeth for chewing, give him a piece of toasted bread, hard enough so that he must chew it before swallowing. Be sure that the flour used in his bread is finely ground. If you cannot get tomato or orange or cabbage juice for him, give him some raw potato, scraped off with the bowl of the iron spoon. As he gets older, give him some of the split pulse cooked for the family, but cooked longer, and mashed. Better still, cook some of the sprouted pulse for two or three minutes for him. Cook the milder fruits which the children bring home, sweeten them and give him the juice. Later he can have the pulp. As he grows, increase the milk, to at least half a quart.

This might go on indefinitely, with all of the detailed instructions used in America for new mothers. It may sound inadequate from the Western point of view. But it is so far beyond present practices in our village that it sounds like the chapter in Mr. Brayne's "Remaking of Village India", called "The Dream".

The reasons for most of the foregoing suggestions are obvious. The suggestions to the village elders are explained by what I have already said of present custom and the shortcomings of the local food supply. The elders demand that each proposal will bring them profit, economic or religious. Health has not yet become equally important with these two. Furthermore, the elders must be satisfied that the proposals are worthwhile before anyone else in the village will consider carrying them out. All this demands more tact and resourcefulness than scientific information.

The reasons for the suggestions concerning foods for children are as follows:

Wheat yields more fat and more minerals per 100 calories than the other cereals do. Moreover experiments have shown that the proteins of wheat more successfully supplement those of pulses, or legumes. McCollum and Simmonds in studying vegetable proteins conclude that "There are however, some remarkable instances of effective supplementing between certain cereals and certain legume seeds. Conspicuous among these successful combinations is wheat and pea. . . . Maize and pea, fed in combination parallel to the wheat and pea relation just mentioned, was almost a failure for the nutrition of the rat. Animals confined to this diet, the only fault of which lay in its protein moiety grew slowly and remained stunted. Fertility was very low and the second generation increased very slowly in weight." Of the combinations used in their experiments, only the wheat and the maize combined with peas are like our village diets.

Our village friends tell us that they used to eat more wheat. But since foreign trade has been introduced, the price of wheat has gone up from 40 pounds to the rupee, to 16 pounds to the rupee. As a result, they sell as much wheat as possible, and hoard the money, while living on inferior grains.

The pigeon pea is recommended, as a source of protein, partly because a larger percentage of it is absorbed than of other pulses. This was shown by McCay's work, reported on page 396. Also, the studies of Niyogi and his co-workers have shown the pigeon pea to be a comparatively satisfactory source of protein, when used with cereals (page 397).

However, the net value of the protein of Indian Pulses is shown to be only about 50 per cent. of the total protein content (page 397). This means great waste, and unprofitable expenditure of energy in its digestion and assimilation.

For this reason, milk or buttermilk are proposed to replace a part of the protein now contributed by pulses. A larger percentage of the protein of milk is assimilated than that of pulses, and the amino acid content of milk protein is more complete. At the same time, milk supplies other materials, such as vitamin A, and provides the calcium in which village diets are conspicuously deficient. Because of these qualities of milk, McCollum calls it a "protective food." "Milk and the leafy vegetables are the only foods so constituted as to make good the deficiencies of cereal grains, legume seeds, tubers, roots and muscle meats. For this reason, McCollum proposed that these foods should be designated "protective foods" in order to give them the prominence they deserve." (55).

(55) See References.

A number of experiments have been made, testing the effect of milk on children. The following from New Zealand where life is comparable to that in our village, is of interest to us. It is reported in Nutrition Abstracts and Reviews, Volume II, no. 2. A test group of 93 Maori children (age 5 to 14 years) received fresh milk daily (½ to 1 pint per child) for 13 weeks, during which period records were kept of their height and weight. Children of another school provided a control group. The children in the test group showed twice the increase in height and two and a half times the gain in weight of those in the control group.

A marked decrease in the incidence of scabies and impetigo was noted among the children receiving milk. There also seemed to be an improvement in their mental alertness. (56).

Butter is suggested to replace ghee on the supposition that in the long standing and heating preparatory to the final production of ghee, there is a loss in vitamin A. And the village diet needs a supply of vitamin A badly. This is evidenced by the sore eyes and the corneal ulcers shown us by parents who hope that we can magically restore sight. When the butter is heated and strained, much of the protein is strained out, and some of the minerals undoubtedly go with it. We have no exact information on this. Ghee is such an important item in diets all over India that it will surely receive examination from Indian nutritionists.

Egg yolk is suggested as another possible source of vitamin A combined with fat and iron and protein of high value. But the adoption of eggs is very doubtful among caste Hindus. For this same reason, meat was not suggested as a children's food, in the list above. The prejudice against it is even greater than that against eggs. Moreover, the meat now available comes from old, decrepit animals, and cannot be recommended for children.

Carrots are advised chiefly because of their vitamin A content.

Potatoes are suggested as a substitute for part of the cereal, now consumed in such large quantities. They are a cheap source of carbohydrate, and at the same time bring in certain constituents such as vitamin C, and iron, which cereals provide in lesser amounts, in proportion to calories supplied.

The germinating legume seeds, and green vegetables are easily obtained contributors of vitamin C, along with the mangoes and tamarinds, and certain other fruits. Oranges are within reach, and may come into use gradually. But the introduction of tomatoes, while simpler from the physical standpoint, will depend on influence other than soil, or nutrition.

All of these suggestions are general, and will require special application in individual cases. I have no illusions as to the difficulty of securing their adoption. Back in the village, I shall be bound by the circle of complicating factors. But each suggestion will find reception somewhere. In high caste homes, where eggs are taboo, there is usually an abundance of milk, and great respect for any product of the cow. In outcaste homes where there is little or no milk, chickens are kept. Even in these outcaste homes, a goat is possible, thanks to free grazing.

(56) See References.

The feeding of babies during weaning, as given in the list for new mothers above, is a task which we must undertake seriously. I have gone through the experience with mother after mother, of watching a beautiful baby wither, and feebly slip away. And we have not known what to do. Also, I have gone through the suspense of the feeding of my own babies, and appreciate what it means to have guidance at this time. At present some of our babies gradually starve to death on mother's milk, while their mothers pride themselves on the fact that the babies want no other food. Others find themselves suddenly replaced by a new brother or sister, with coarse cereal cakes and stewed pulse as their new fare. There is a disease called "sukhi" (drying up) among our babies. We could not locate its source, but now I believe that it can be traced to one or perhaps both of the above situations.

There are various methods of treating "sukhi," chiefly with charms and taboos. But I have found no suggestion of its relation to faulty nutrition. It is one phase of feeding which I want most to study on our return to the village.

THE PROBLEM

In approaching this problem of foods in our Hindu village of North India, we should inform ourselves on the following:

(1) The people, their physical condition, including resistance to disease.

(2) The attitude of the people towards suggested practices.

(3) The foods available, locally, with some information on the comparative consumption of each.

(4) The treatment of the foods, including customary practices.

(5) The value of foods used.

We have acquainted ourselves with the first, third and fourth of these through personal observation and inquiry. With the help of medical friends we hope to learn more of the physcal condition of the people when we return among them. Our information on the fifth point comes from various sources, chiefly Western. This field has scarcely been touched in India. The second opens up a whole new field which we hope to investigate.

In trying to solve the problem of how to make the foods of our Hindu village more adequate, further points must be kept in mind.

(1) The foods emphasized should be among those available and those acceptable to at least a part of the community.

(2) The proposals in regard to the treatment of food should be built on familiar practice and should be made with consideration for existing custom and prejudice.

(3) The values of foods recommended, and the treatment of them suggested, should be built upon evidence presented by reputable scientists.

I have kept these points before me in presenting solutions of the problem. With my own knowledge of the foods available, and of current food practices, and with the support of McCarrison, McCollum, Rose, Sherman and others, I know that my suggestions are harmless, at least. With the example of the Sikhs who live not far

from us and who have practically the same food resources as our people, I know that we are striving toward something attainable and worthwhile. The problem has resolved itself to a simple matching of human needs and a comparatively satisfactory food supply. McCarrison has expressed the result very simply in his Primer intended for Indian school children.

"The right kind of food for Indian children and indeed, for children in any country is one made up of the following simple things: (1) any whole cereal grain or mixture of cereal grains; (2) plenty of milk and the products of milk—curds, buttermilk, butter, *ghee;* (3) sprouted pulses; (4) eggs or liver, or meat, or fish occasionally, if religion permits their use; (5) tuber and root vegetables; (6) abundance of green leafy vegetables; and, (7) fruit."

It sounds very simple. And we have satisfied ourselves that it is right.

But the hardest task of all remains. Our village folk are illiterate and their lives are directed by custom, and fear of spirits. We cannot give them the reasons which Science offers for adopting the new food practices recommended here. The propaganda method of the English commissioner did not prove itself lasting after his departure. Then, how are we going to help our people to feel a need for better food to such an extent that they will be ready to improve their food resources, and improve the methods of utilizing those resources? This step carries us from the present study into a whole new field. On our success in exploring this new field, the effectiveness of our solution of the food problem rests. We must carry our information back to our village and translate it into village terms, with the help of educated Indian friends who can interpret for us. They know the world of spirits in which villagers dwell, better than we do.

An illustration of this is one of the many stories told about a gallant Indian woman lawyer who goes into remote sections of the country in connexion with her official duties. Once while visiting a home where her women clients were particularly superstitious, she found them in terror of the threatened visit of the smallpox goddess. The goddess had already brought tragedy to several of their neighbours. They were using all of the charms within their reach to persuade her to pass their house by. The educated Indian woman knew the futility of urging vaccination in this home. She asked the women if the smallpox goddess did not like a sacrifice of blood. They agreed that she did. Then said the educated woman, "I know a spirit charmer who wards off the smallpox goddess by blood sacrifice. Each of you may share in the offering." They had already employed the services of local spirit charmers, and were ready to try another. The educated woman drove to the nearest town and brought the district vaccinator back with her. He was allowed to scratch the arm of every one in the family. They were warned that in a few days the goddess would come, but learning of their blood sacrifice, she would pass on without the usual terrible visit. Women like this, rather than scientists, can help us in the study of present attitudes, and in the task of interpreting in terms of those attitudes. Education is slowly reaching the villages. But until it is much better than at present, we do not want our people

to cast everything of the past aside. In so doing they would lose much of value which experience has taught them.

I should like to close this study, with a suggestion of the future of nutrition in India. In 1928, the following statement was made by the Royal Commission on Agriculture:

"The problems of human nutrition, which have only recently come into prominence are being investigated by Colonel McCarrison who is working under the Research Fund Association at Coonoor. He lays emphasis on malnutrition as a problem facing those engaged in agricultural research. In his inquiries, Colonel McCarrison invokes the aid of the agricultural departments. The problems of human and animal nutrition are likely to assume such importance that we consider it desirable that work on human nutrition and on the nutrition of farm animals should be carried out in the closest co-operation, or, in other words, that there should be team work by workers with a knowledge of different branches of the science of nutrition. Continuity is also essential. The various workers on nutrition problems should be formed into a committee on nutrition which would meet at regular intervals to discuss common questions. This would assure the requisite close touch between different branches of the subject. In view of the importance of the subject, we recommend that a central institute of human nutrition should be established." (57).

Since this report, the important work carried on at Coonoor has continued, under the direction of Sir Robert McCarrison, until his recent retirement. His successor, Dr. W. R. Aykroyd, has a record of thorough scientific research. To this he is rapidly adding an interest in ways of meeting the nutritional needs of poorer families in India. He has already worked out an adequate diet which is low in cost, and available in villages. Meanwhile, further research is being conducted, and applied practically in the All-India Institute of Hygiene and Public Health, Calcutta. There are other centres of useful research, in Calcutta, Bangalore, Bombay, and Allahabad. Indian food-stuffs are being analysed, so that we shall no longer depend upon Western tables. Ordinary diets are being tested, both in laboratories and in boarding institutions.

The most recent move has been the correlaton of these scattered studies. During the last Indian Science Congress, in Indore, in February, 1936, an Indian Nutrition Committee was formed. And still more recently, our new Viceroy revived the above quoted suggestions of the Royal Commission of which he was chairman, at the opening meeting of the new Nutrition Advisory Committee of the Indian Research Fund Association. We look upon this committee as the beginning of active, unified interest in human nutrition in India.

Meanwhile, public interest in this subject has been growing; popular lectures on diet problems now have their place in gatherings to promote public welfare. Leaflets are being prepared like that issued by the Bombay Presidency Baby and Health Week Association on Balanced Diets. Newspapers and magazines now publish

(57) See References.

more articles on nutrition within a month than they did in a year when the Royal Commission first proposed an institute of human nutrition.

All of this is bound to influence the literate townsman. But much more must be done, to reach the illiterate villager and his wife. Perhaps establishing literacy is the first step. To quote from the Viceroy's speech at the opening of the Nutrition Advisory Committee: "I am entirely convinced that, whether we are concerned to advance among the rural population improved agricultural practice or better sanitation and hygiene or better nutrition, we shall find that our best endeavours will achieve little that will endure unless and until literacy is imparted to the women of the countryside. We may bring about some considerable degree of improvement under existing conditions by means of intensive propaganda and close supervision, but in default of female literacy it will be found that whenever supervision is removed there will be a relapse into age-old customs and that, within a few months, nothing will be left of the better living that has been so laboriously inculcated." While literacy is being made possible, we must find ways of presenting better nutrition in terms of a villager's experience. He is suspicious of anything new or strange. If we press upon him, ideas which have not been carefully tested, or ideas which involve drastic change, we shall strengthen his prejudice against what he regards as interference. But he and his wife will gladly accept one simple suggestion at a time, if they understand its benefit and see that this benefit can be attained without additional cost. They are too poor to risk even a pice in experimenting. And while their simple, very practical learning is going on, we can educate their children toward an understanding and appreciation of the purposes and results of Science.

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